OPERATIVE

AND

DENTAL ANATOMY TECHNICS

McGEHEE

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A CLASS-ROOM AND LABORATORY MANUAL

FOR

FRESHMEN DENTAL STUDENTS

BY

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DEDICATION.

TO

HELEN NYE,

FAITHFUL AND LOVING WIFE, WHO, BY HER INFINITE PATIENCE, INTELLIGENT COUNSEL, UNSELFISH SACRIFICES AND UNFAILING INTEREST AND DEVOTION, INSPIRES ALL HIS EFFORTS, THIS BOOK IS DEDICATED BY HER HUSBAND, *THE AUTHOR.*

PREFACE

"The permanence of all books is fixed by no effort friendly or hostile, but by their own specific gravity, or the intrinsic importance of their contents to the constant mind of man."—Emerson.

While this book is written primarily to fill a long-felt need in presenting the subjects of Dental Anatomy and Operative Technics before his own classes, the author believes it will also meet the needs of teachers of the subject in other schools, and relieve them of the tedium of culling from larger texts material for the preparation of lectures and the mapping out of an adequate technic course.

The existence of two such excellent works on Dental Anatomy as those of Broomell-Fischelis and Black precludes the necessity of another. The chapter on Dental Anatomy, then, is intended only as an aid to the teaching and study of one or the other of these books, outlining a technic course on the subject, modeled to suit the needs of the average student after consultation with some of the most prominent teachers of the subject in this country. The book is not intended to supplant the text-books on Operative Dentistry at present in use; but it is a recognized fact that these are all too voluminous for use as a text by freshmen students, in acquiring the limited knowledge of the subject necessary for the performance of the various exercises in the operative technic laboratory. No especial effort, therefore, has been made to enter into a discussion of the causes of things, leaving a consideration of the **why** and **wherefore** for investigation on the part of the student

in his junior and senior years. The effort has been made to so condense, simplify and systematize the presentation of the subject matter that it will at once attract the eye and hold the attention of the as yet untrained mind.

Very little of originality, except in the presentation of the subject, is claimed for the work, the author having in the main followed the accepted teachings of such writers as G. V. Black, A. E. Webster, Thomas E. Weeks, D. M. Cattell, Fred W. Gethro, C. N. Johnson, D. M. Gallie, Marcus L. Ward, John Sayre Marshall, I. N. Broomell, Philipp Fischelis, Otto E. Inglis, J. P. Buckley, L. M. Waugh, Chas. J. Essig, Augustus Koenig, J. D. Hodgen, W. Clyde Davis and others.

The writer has endeavored to follow out in the presentation of the subject the ideas accepted and recommended by the INSTITUTE OF DENTAL PEDAGOGICS as incorporated in the published transactions of that body, and the work has been examined by the **Commission on Text-books** of that organization.

The technic exercises have been outlined after a study of the courses as taught in many of the prominent schools, and after an experience of fifteen years as a teacher of the subject. They may be modified according to the judgment of the teacher to suit the needs of any classes.

If the work proves to be of assistance to teachers in outlining their courses and to the great body of young men yearly entering upon the study of a noble profession, in acquiring a knowledge of the subjects of **Dental Anatomy** and elementary **Operative Dentistry,** the author will feel well repaid for the labor expended in its preparation.

CINCINNATI, OHIO, 1913.

CONTENTS

LIST OF ILLUSTRATIONS

A TALK WITH THE STUDENT

"The greatest trust between man and man is the trust of giving counsel."—Francis Bacon.

"How to live, that is the essential question for us."—Herbert Spencer.

Dear Student:

You are now entering upon the serious study of an elevated and noble profession, with your banner unfurled to the breeze and hope beating high in your breast. Advice from one who has passed through the same experiences which are soon to be yours should not be amiss.

You are now laying the foundations for your professional career. Let me urge you to place them deeply and broadly, in order that they may not totter and succumb under the weight of the superstructure which is to be raised upon them during the years to come. Your college life is the most important part of this architectural design. Your character is now in the process of formation, whether you will or no; habits are being formed, friendships are being made, which will influence your entire life. This being the case, it behooves you to pause with me for a few moments and consider the situation—to take a mental view of the landscape, which appears so bright and rosy and full of promise.

Let me urge you to be careful in selecting your social companions. You are probably now in a strange city, surrounded by many temptations, away from home restraints and the loving counsels of your parents, who, expecting much of you, have sent you forth into the world to fulfill your mission in

life. Do not allow them to be disappointed. The care with which you choose your friends, the selection of the social circle in which you are to move, will greatly influence the development of your character and that personality which is to make or mar your future.

You should respect and endeavor to follow to the utmost the advice and teachings of your instructors. Make diligent effort to master the theoretical and technical studies with which you will be surrounded throughout your college course. Many students make the error of feeling satisfied if they have made a passing grade on theory and have more or less satisfactorily completed the requirements designated by the faculty of the school. You will make a serious mistake if you allow only this to be your aim, as you will fall far short of bringing out the best of your capabilities. Let me advise you to look at the matter from a much broader standpoint. Your chief aim should be to endeavor so to equip yourself for your life's work, and so to perfect yourself in your chosen profession, that you may be enabled to stand shoulder to shoulder with your future co-laborers, and intelligently serve those to whom you expect to minister.

Some are endowed with ambition to excel and stand above their fellows. Perhaps you, yourself, already have this idea, or have your thoughts fixed toward some prize which is offered by your teacher. This is all very well, but the idea of *primarily* working for a prize or reward does not always stimulate to the best efforts. John Ruskin says: "A man or woman in private or public life, whoever works only for the sake of the reward which comes for the work will in the long run do poor work always. I do not care where the work is, the man or woman who does work worth doing is the man or woman who lives, breathes, and sleeps that work, with whom it is ever present in his or her soul; whose ambition it is to *do*

it well and feel rewarded by the thought of having done it well. That man or woman puts the whole country under an obligation." Read the quotation again! The italics have been placed there by myself, because that is the important clause. *Do your work well*, not primarily for the sake of any pecuniary reward or attractive prominence which it may give you, but to *satisfy your own conscience.* Ralph Waldo Emerson means practically the same thing when he says: "Work in every hour, paid or unpaid, see that thou work and thou canst not escape the reward; whether thy work be fine or coarse, planting corn or writing epics, so only it be honest work, done to thine own approbation, it shall earn a reward to the senses as well as to the thought; no matter how often defeated, you are born to victory. The reward of a thing well done is to have done it."

I would impress upon you the broad scope and scientific nature of the profession which you are entering. The dentist is constantly working on living tissues which have an intimate relationship with all parts of the body. His work is founded on a thorough knowledge of Anatomy, Physiology, Chemistry, Materia Medica and Pathology, as well as an understanding of physical and mechanical laws. He should at all times be prepared to write prescriptions for the treatment of oral diseases; he should be fully competent to make a physical inspection of the heart and lungs, as well as an examination of the salivary and other secretions of the body; he should understand the administration of general and local anesthetics, his sense of the esthetic and artistic must be highly developed; and he must be prepared to do many other things of which you will learn later in your course. Do not imagine, then, that your chief functions are to be those of the artisan or mechanic. He who holds this narrow view of the profession and imagines that dentistry consists largely in the packing

of a little gold or amalgam into a cavity in a tooth is wanting in knowledge.

In addition to perfecting yourself in a knowledge of dentistry I would advise that you devote a portion of your time to the acquirement of general information. There is nothing which has a more broadening influence than the reading of good literature. The man who knows nothing outside of his own calling soon degenerates and becomes small and narrow. The public expects the professional man to know something about everything, and will frequently place a low estimate on your ability, if you do not measure up to its expectations in this direction.

You should not only continue the pursuit of general and professional knowledge, but should also sedulously cultivate the habit of close observation and investigation. Learn how to exercise the faculty of thought and thus develop ideas of your own. "Read not to contradict and confute, nor to believe and take for granted, nor to find talk and discourse, but to weigh and consider. Some books are to be tasted, others to be swallowed and some few to be chewed and digested."—Lord Bacon.

Close attention to minutiæ and detail are possibly of more importance in dentistry than in any other vocation. When one remembers the small size of the oral cavity and the many minute and delicate operations which the dentist is constantly called upon to perform within this limited field, then only can one appreciate the importance of absolute exactness and attention to detail in the work. Each step of every operation should be made perfect before another is undertaken, if a perfect result is to be obtained. No part can be slighted or hurried. Make up your mind *now* never to let a piece of defective work go from your hands. Do it over and over again

until you have done your *very best.* Your conscience is your best mentor in this, as in everything else.

Your constant aim should be perfection. Set the word **Perfection** up as your ideal and make it your daily endeavor to reach that ideal. He who constantly works with that end in view will make a success in his calling.

*"If a man can write a better Book—
Or preach a better Sermon—
Or make a better Mousetrap than his neighbor—
Though he build his house in the woods,
The world would make a beaten
Track to his door."

And now, dear student, I could go on and on, but it is not necessary. If you will follow the precepts here laid down for your guidance you will never have cause for regret. With the hope that the following pages may be of interest and benefit, I will repeat to you the advice of Polonius to his son, who was leaving home for a journey into France:

Polonius: Yet here, Laertes! aboard, aboard, for shame!
The wind sits in the shoulder of your sail,
And you are stay'd for. There; my blessing with thee!
And these few precepts in thy memory
See thou character. Give thy thoughts no tongue,
Nor any unproportion'd thought his act.
Be thou familiar, but by no means vulgar.
Those friends thou hast, and their adoption tried,
Grapple them to thy soul with hoops of steel;
But do not dull thy palm with entertainment
Of each new-hatch'd, unfledged comrade. Beware
Of entrance to a quarrel, but being in,

*Attributed to Emerson, though not proven.

Bear't that the opposed may beware of thee.
Give every man thy ear, but few thy voice;
Take each man's censure, but reserve thy judgment.
Costly thy habit as thy purse can buy,
But not express'd in fancy; rich, not gaudy;
For the apparel oft proclaims the man.
And they in France of the best rank and station
Are of a most select and generous chief in that.
Neither a borrower nor a lender be;
For loan oft loses both itself and friend,
And borrowing dulls the edge of husbandry.
This above all; to thine own self be true,
And it must follow, as the night the day,
Thou cans't not then be false to any man.
Farewell; my blessing season this in thee!

(Hamlet, Act I., Scene III.)

OPERATIVE AND DENTAL ANATOMY TECHNICS

CHAPTER I

DENTAL ANATOMY

HOW TO STUDY IT—HOW TO PERFORM THE TECHNIC OPERATIONS—HOW TO REVIEW FOR EXAMINATION

Text-books.—Dental Anatomy, Black; or Anatomy and Histology of the Mouth and Teeth, Broomell and Fischelis.

HOW TO STUDY THE SUBJECT

The study of Dental Anatomy will develop into an interesting and profitable pastime or a dull and lifeless labor, depending upon the standpoint from which its intricacies are approached. In a sense, it is really the foundation on which is to be built all dental knowledge, a thorough familiarity with the external and internal forms of the teeth, their points of interest and their intimate relationships with each other being absolutely essential to a complete understanding of the other branches of the curriculum. It has a direct bearing on all of these subjects, and the student should realize *now* that if he wishes to become proficient in the science and art of filling teeth, of making crowns, bridges and plates, and all of the procedures incident to the practice of dentistry, he should first learn this subject. In making the drawings, carving the blocks

and filing the sections—in performing all the technic operations—he should do so *intelligently and thoroughly*, and with the view to deriving as much practical benefit as possible from the procedures; else much of his time is being wasted and the work rapidly degenerates into uninteresting drudgery.

(The appended references refer to paragraph numbers in

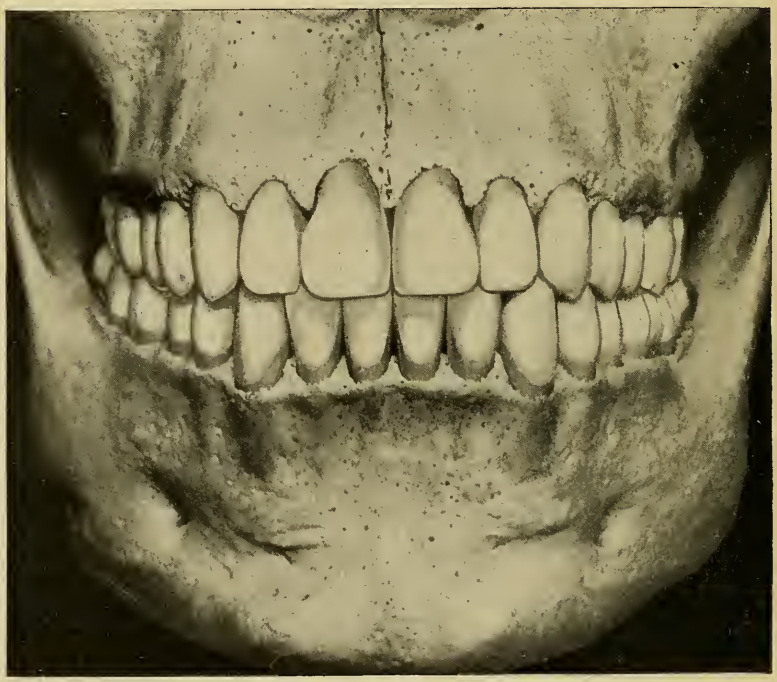


FIG. 1.—Occlusion of the teeth. Anterior view.

Black's Dental Anatomy, or to page numbers in the text or in Broomell and Fischelis' Anatomy and Histology of the Mouth and Teeth. B. = Black; B.F. = Broomell and Fischelis; Par. = paragraph; pp. = page; fig. = figure.)

1. Study the Glossary of Black's Dental Anatomy. *B. pp. IX–XVII.*

2. Study the **names, number and arrangement** of the teeth, in the upper and lower jaw. *B. par.* 1, 2, 187 *to* 192. *B.F. pp.* 73, 74.
3. Study the general characteristics of the teeth and the form

FIG. 2.—Occlusion of the teeth. Lateral view.

of the arch in the **sanguine, bilious, nervous** and **lymphatic** temperaments. *B. fig.* 126, *par.* 187 *to* 188. *B.F. pp.* 77, 78, 83.
4. Study the **occlusion** of the teeth (Figs. 1 and 2). *B. par.* 190. *B.F. pp.* 85 *to* 90.

5. Distinguish the difference between **occlusion** and **articulation.** *B.F. pp.* 85 *and* 86.
6. Distinguish between the **interproximal space** and the **interproximal embrasure.** *B. par.* 13, 193 *and* 194.
7. Study the **formula** for the permanent and deciduous teeth. *B. par.* 2 *and* 128. *B.F. pp.* 75.

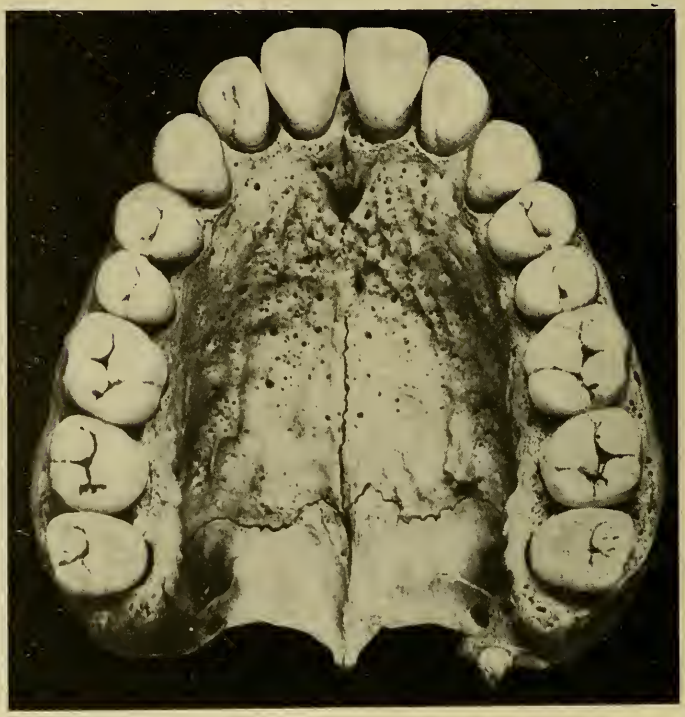


FIG. 3.—The upper arch.

8. Learn **Palmer's notation.** *Text pp.* 9.
9. Remember that the **gingival line** of Black and the **cervical line** of Broomell are the same. *B. par.* 3. *B.F. pp.* 101.
10. Remember that Broomell calls the free margin of the gum

the **gingival line,** while Black speaks of it as the **gingiva** or **gingival margin.** *B. par.* 211, *B.F. pp.* 101.

11. Study the **characteristics of the tissues** of which a tooth is composed. *B.F. pp.* 72.
12. Study and learn the definition of the parts of a tooth, such

Fig. 4.—The lower arch.

as **crown, root, neck, apex, pulp chamber, canals, apical foramen;** also the names of the **surfaces and angles.** *B. par.* 3, 4, 5, 6, 7, 8. *B.F. pp.* 72 *and* 75.

13. Study the difference between a **cusp** and a **tubercle;** a **fossa, sulcus, groove, and fissure.** *B. Glossary. Also par.* 8, 10, 11.
14. Distinguish between the three varieties of **ridge.** *B. par.* 9.

15. Distinguish between the three varieties of **groove.** *B. par.* 11 *and* 12.
16. Study the relation of the **line of occlusion** to the **facial angle** (Figs. 5 and 6). *B.F. pp.* 87 *and* 88.
17. Study the difference between the **thick neck** and **bell-crown** teeth and the bearing of these on the shape of the

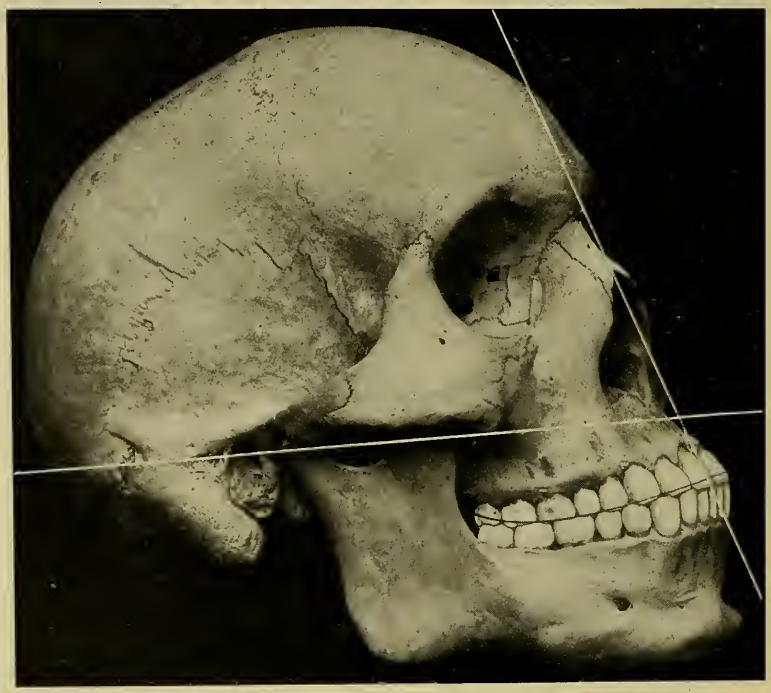


FIG. 5.—The facial angle and line of occlusion.

interproximal space and the shape and size of the **contact point.** *B. par.* 14, 18, 194, 195. *B.F. pp.* 83.

18. Study the **method of attachment** of the teeth in the sockets. *B. par.* 196, 197, 206. *B.F. pp.* 73.
19. Study the **upper and lower incisors** as a group, noting differences in shape, size, location and inclination. *B.*

par. 16 *to* 31, 191 *to* 192. *B.F. pp.* 110 *to* 124, 172 *to* 177—*also* 78, 79, 80, 81 *and* 82.

20. Study the surfaces, margins, angles, ridges, grooves and lobes of these.

FIG. 6.—The compensating curve or the curve of Spee.

21. Study the **upper and lower cuspids** in the same manner.
22. Study the **upper and lower bicuspids** together in the same way.
23. Study the **molars.**
24. Study the differences between the **permanent and de-**

ciduous teeth as to number, size, shape, color, length of roots, constriction of neck and inclination of buccal and lingual surfaces. *B. par.* 128 *to* 133. *B.F. pp.* 224, 225.

25. Study the anatomy of the **temporary first and second molars,** upper and lower. *B. par.* 129, 134 *to* 151. *B.F. pp.* 231 *to* 233, 236 *to* 238.
26. Study the form and size of the **pulp chamber and canals** in the permanent teeth while making the sections and prints in the technic course.
27. Select from a miscellaneous lot the teeth of the various denominations.
28. Study the form, location and size of the **contact points** on all of the teeth. *B. par.* 195. *Fig.* 132 *to* 136. *B.F. pp.* 84.
29. Make the drawings and carvings of the teeth as outlined in the technic course, while studying their surface form.

HOW TO PERFORM THE TECHNIC OPERATIONS

Materials and Instruments Required

1. Note book (I. P., loose leaf, No. 9108, for memoranda and drawings).
2. Set of ivory or vegetable ivory blocks (Harper's, Tenney's or cut to order); or set of soap or French chalk blocks; or set of plaster-of-Paris blocks.
3. Wood blocks 1 1/4×3/4×3/4 inches.
4. Stick United States Express sealing wax.
5. Half dozen smooth broaches (round).
6. Half round, 10-inch file, bastard cut, medium coarse.
7. Bunsen burner and tubing, or alcohol lamp.
8. Small bench vise.
9. Mechanical saw frame, 12 saws.
10. Wax spatula.

11. Plaster bowl and spatula.
12. Plaster knife.
13. Vulcanite chisels.
14. Vulcanite scrapers.
15. Vulcanite file, half round.
16. Boley millimeter gauge.
17. Sheet fine sandpaper.
18. Nail brush and coarse cloth.
19. Blue pencil.
20. Operative chisels and excavators.
21. Ruled paper for prints.
22. Mouth blowpipe.
23. Wood modeling board and modeling tools.

The technic exercises in Dental Anatomy to be described consist of outline and shaded drawings of the surface form and internal anatomy of various teeth, modeling in clay, carving teeth in plaster, soap, French chalk and ivory, the sawing and filing of sections (showing the outline form of the pulp chamber and canals) and the making of prints or silhouettes from these sections. All of the exercises described may be modified to suit the needs of various classes, in the judgment of the teacher. The denomination and number of teeth to be selected will have to be regulated by the amount of time devoted to the work and whether all or only a part of the technical exercises here described are to be performed. The drawings, carvings, sections and prints, where necessary, should be annotated after Palmer's notation.

Palmer's Notation

Permanent teeth

8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8

Deciduous teeth

V	IV	III	II	I	I	II	III	IV	V
V	IV	III	II	I	I	II	III	IV	V

The drawings and carvings should be done to Black's average measurements, natural size or enlarged as indicated, by means of a Boley millimeter gauge (Fig. 60).

Average Measurements of the Teeth, Taken from Black's Dental Anatomy

"The lines of measurement are:

1st. "Length over all": Length of the tooth from the cutting edge, or buccal cusp, to the apex of the root.

2nd. "Length of crown": Length of the crown from the cutting edge, or buccal cusp, to the gingival line on the labial or buccal surface.

3rd. "Length of root": Length of root from the gingival line on the buccal surface to the apex of the root.

4th. "Mesio-distal diameter of crown": This is the extent from mesial to distal in the greatest diameter, or at the points of proximate contact.

5th. "Mesio-distal diameter of neck": This measurement was made at the gingival line.

6th. "Labio- or bucco-lingual diameter": This measurement was taken at the greatest diameter of the crown in the direction named. In the incisors it was on the gingival ridge. In the bicuspids and molars it was generally mid-length of the crown, but occasionally it was near the gingival line, especially in the upper second and third molars.

7th. "Curvature of the gingival line": This is the height or extent of the curve of the gingival line toward the cutting edge, or occlusal surface, as it passes from labial to lingual, measured on the mesial surface."

UPPER TEETH.

Table of Measurements of the teeth of man, given in millimeters and tenths of millimeters. UPPER TEETH	Length over all.	Length of crown.	Length of root.	Mesio-distal diam. of crown.	Mesio-distal diam. of neck.	Labio- or bucco-lingual diam.	Curvature of the gingival line.
Central Incisor. Average.	22.5	10.0	12.0	9.0	6.3	7.0	3.0
Lateral Incisor. Average.	22.0	8.8	13.0	6.4	4.4	6.0	2.8
Cuspid. Average.	26.5	9.5	17.3	7.6	5.2	8.0	2.5
First Bicuspid. Average.	20.6	8.2	12.4	7.2	4.9	9.1	1.1
Second Bicuspid Average.	21.5	7.5	14.0	6.8	5.3	8.8	0.8
First Molar. Average.	20.8	7.7	13.2	10.7	7.5	11.8	2.2
Second Molar. Average.	20.0	7.2	13.0	9.2	6.7	11.5	1.6
Third Molar. Average.	17.1	6.3	11.4	8.6	6.1	10.6	0.7

NOTE.—This table and the one on the following page are taken from Black's Dental Anatomy.

LOWER TEETH.

Table of measurements of the teeth of man, given in millimeters and tenths of millimeters. LOWER TEETH	Length over all.	Length of crown.	Length of root.	Mesio-distal diam. of crown.	Mesio-distal diam. of neck.	Labio- or bucco-lingual diam.	Curvature of the gingival line.
Central Incisor. Average.	20.7	8.8	11.8	5.4	3.5	6.0	2 5
Lateral Incisor. Average.	21.1	9.6	12.7	5.9	3.8	6.4	2:5
Cuspid. Average.	25.6	10.3	15.3	6.9	5.2	7.9	2:9
First Bicuspid. Average.	21.6	7.8	14.0	6.9	4.7	7.7	0.8
Second Bicuspid. Average.	22.3	7.9	14.4	7.1	4.8	8.0	0.6
First Molar. Average.	21.0	7.7	13.2	11.2	8.5	10.3	1.1
Second Molar. Average.	19.8	6.9	12.9	10.7	8.1	10.1	0.2
Third Molar. Average.	18.5	6.7	11.8	10.7	8.3	9.8	0.2

Drawings

1. Outline the labial surface of the crown and root of $\underline{1}$ three times enlarged, according to Black's measurements, showing labial grooves, curvature of cervical line (gingival line of Black), shape of mesio- and disto-incisal angles. The root is conical in shape and the labial surface of the crown

NOTE.—The original drawings for the illustrations in this section were made by student W. G. Pieck, class of 1915, Ohio College of Dental Surgery.

irregularly square or trapezoidal. If the bases of a **pyramid** and a **trapezoid** are placed together, as in Fig. 7, the diagram may be made within.

2. Outline the mesial or distal surface of the crown and

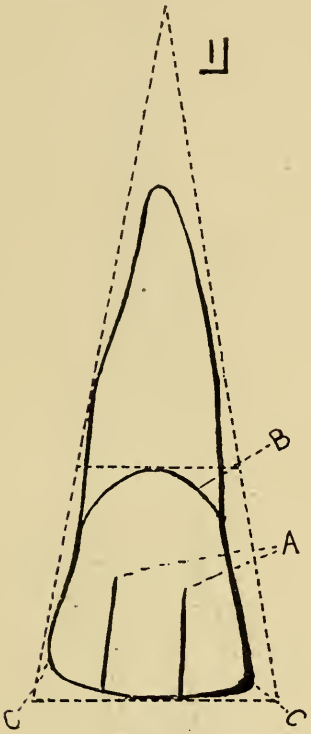


FIG. 7.—Right upper central incisor. Labial surface. *A*, labial grooves; *B*, curvature of cervical line; *C*, mesio and disto-incisal angles.

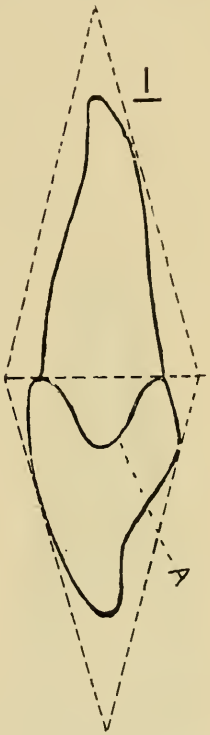


FIG. 8.—Upper central incisor. Mesial surface. *A*, Cervical line.

root of $\underline{1}$ three times enlarged, showing curvature of cervical line (gingival line of Black). The proximal surfaces of the crown are wedge shape. Draw a **pyramid** and a **wedge** placed base to base, Fig. 8, and outline the tooth within.

NOTE.—All of the illustrations in this section are about three diameters with the exception of figures 18, 19, 23, 24, 30, 31, 32, 33, 34.

3. Draw and shade a central incisor three times enlarged (Fig. 9).

4. Outline the labial surface of the crown and root of

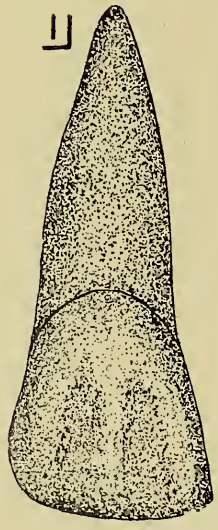


FIG. 9.—Right upper central incisor. Labial surface.

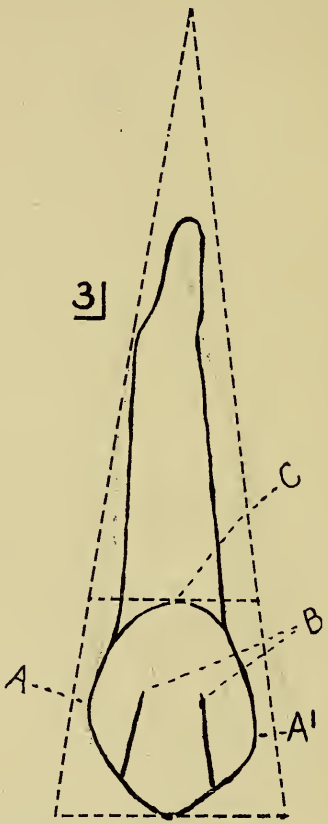


FIG. 10.—Right upper cuspid. Labial surface. *A*, Disto-incisal angle; A^1, mesio incisal angles; *B*, labial grooves; *C*, cervical line.

3 enlarged three times, in the same figure as indicated in No. 1, showing the location of the mesio- and disto-incisal angles, labial grooves, curvature of cervical line (gingival line of Black)(Fig. 10).

5. Draw and shade an upper cuspid (Fig. 11).

6. Outline the buccal surface of the crown and roots of $\underline{4}$, enlarged three times, in the same figure as before used, showing curvature of the cervical line (Broomell), location of angles, location of point of cusp to the *distal* and the buccal grooves (Fig. 12).

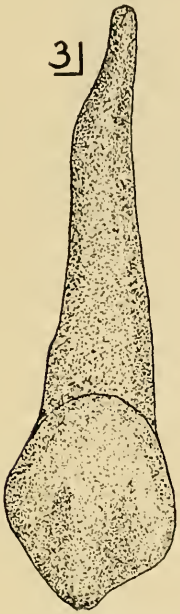


FIG. 11.—Right upper cuspid. Labial surface.

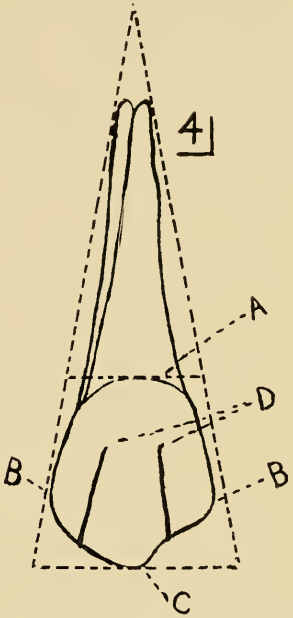


FIG. 12.—Right upper first bicuspid. Buccal surface. A, Cervical line; *B*, mesio- and disto-incisal angles; *C*, point of buccal cusp to the distal; *D*, buccal grooves.

7. Outline the mesial or distal surface of $\underline{4}$ showing two roots and curvature of cervical line (Broomell). The drawing may be made within a **parallelogram** and a **square,** placed base to base, Fig. 13.

8. Draw and shade an upper second bicuspid, showing the point of the buccal cusp to the *mesial* (Fig. 14).

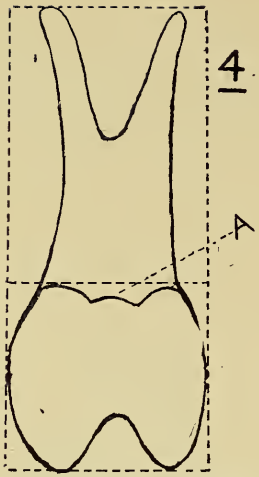


FIG. 13.—Upper first bicuspid. Mesial surface. *A*, Cervical line.

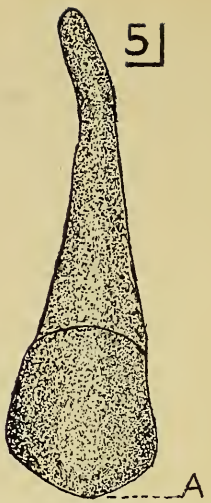


FIG. 14.—Right upper second bicuspid. Buccal surface. *A*, Buccal cusp.

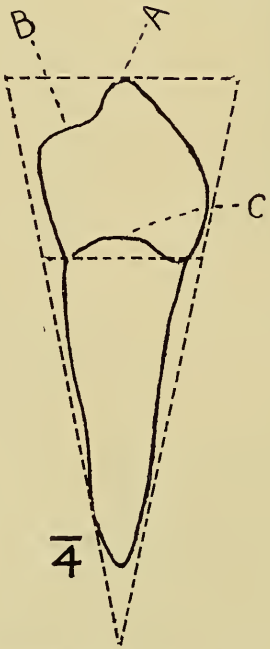


FIG. 15.—Lower first bicuspid. Mesial surface. *A*, Buccal cusp; *B*, lingual cusp; *C*, cervical line.

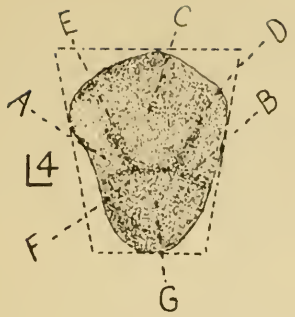


FIG. 16.—Left upper first bicuspid. Occlusal surface. *A*, Mesial marginal ridge; *B*, distal marginal ridge; *C*, buccal triangular ridge; *D*, *E*, triangular grooves; *F*, central groove; *G*, lingual triangular ridge.

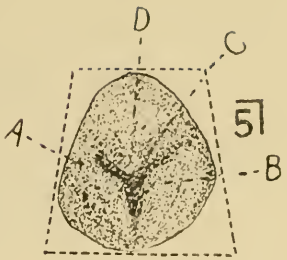


FIG. 17.—Right lower second bicuspid. Occlusal surface. Three cusps. *A*, Mesial marginal ridge; *B*, lingual groove; *C*, distal groove; *D*, buccal cusp.

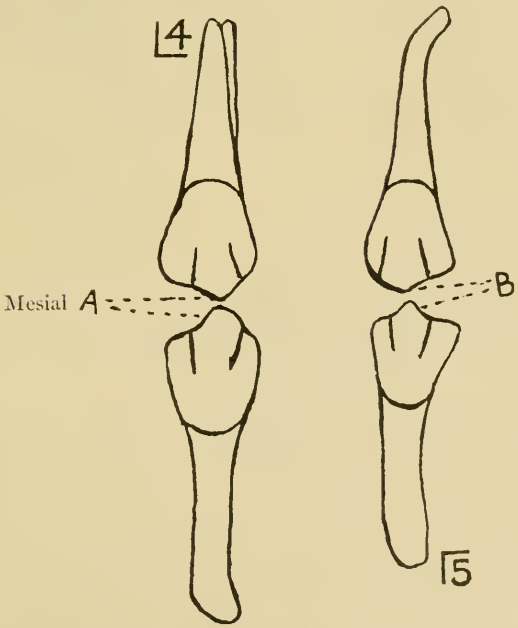


FIG. 18.—Left upper and lower first and second bicuspids. *A*, Points of cusps of first bicuspids nearer to the distal. *B*, Points of cusps of second bicuspids to the mesial.

9. Outline the mesial or distal surface of $\overline{4}$ within a figure as indicated in No. 1 *reversed*, showing relative size of buccal and lingual cusps and curvature of cervical line (Fig. 15).

10. Draw the occlusal surfaces of $\underline{4}$ and $\overline{5}$, three times enlarged, indicating the location of the ridges and grooves by initials on the drawing. Make the drawings within a figure of **trapezoidal** or **keystone shape** (Figs. 16 and 17).

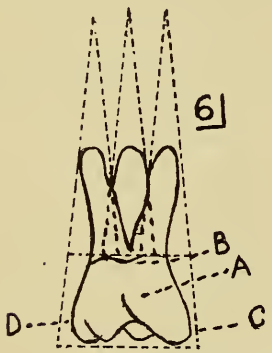


Fig. 19.—Right upper first molar. Buccal surface. *A*, Buccal groove; *B*, cervical line; *C*, mesio-bucco-occlusal angle; *D*, disto-lingual cusp.

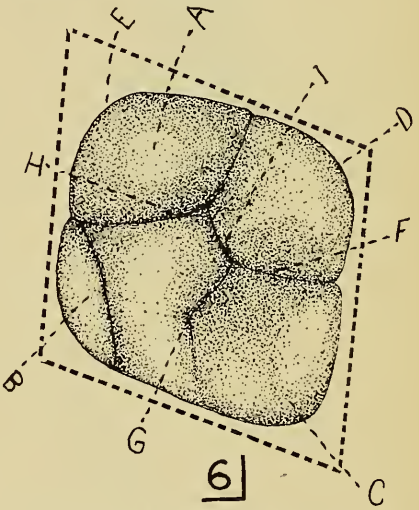


Fig. 20.—Right upper first molar. Occlusal surface. *A*, Disto-lingual cusp; *B*, fifth cusp; *C*, mesio-buccal cusp; *D*, disto-buccal cusp; *E*, disto-lingual angle; *F*, buccal groove; *G*, mesial groove; *H*, disto-lingual groove; *I*, distal groove.

11. Make a drawing showing the location of points of the buccal cusps of $\lfloor\underline{4}$, $\lfloor\underline{5}$ and $\lceil\overline{4}$, $\lceil\overline{5}$. According to Black's Dental Anatomy they are most frequently located as follows, viz.:

Upper first bicuspid, point of the cusp to the distal.

Upper second bicuspid, point of the cusp to the mesial.

Lower first bicuspid, point of the cusp to the distal.

Lower second bicuspid, point of the cusp to the mesial.

This does not obtain in many instances (Fig. 18).

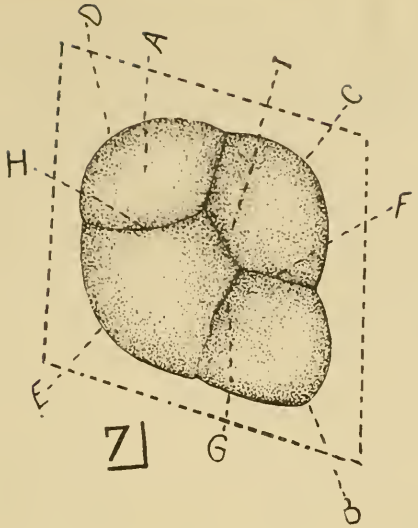


FIG. 21.—Right upper second molar. Occlusal surface. *A*, Disto-lingual cusp; *B*, mesio-buccal angle; *C*, disto-buccal angle; *D*, disto-lingual angle; *E*, mesio-lingual angle; *F*, buccal groove; *G*, mesial groove; *H*, disto-lingual groove; *I*, distal groove.

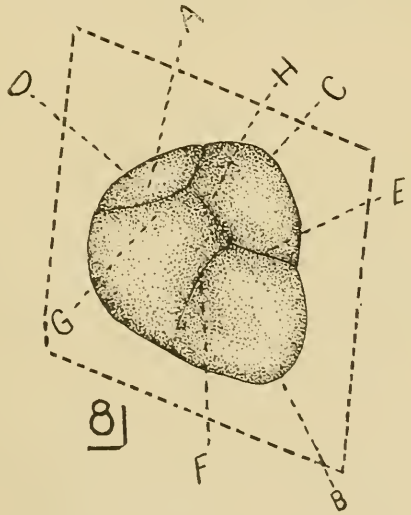


FIG. 22.—Right upper third molar. Occlusal surface. *A*, Disto-lingual cusp; *B*, mesio-buccal angle; *C*, disto-buccal angle; *D*, disto-lingual angle; *E*, buccal groove; *F*, mesial groove; *G*, mesio-lingual cusp; *H*, distal groove.

12. Outline a figure (Fig. 19) consisting of three **pyramids** and a **trapezoid,** placed base to base, and draw the buccal aspect of $\underline{6}$ showing three roots, buccal groove, curvature of the cervical line and location of the mesio- and disto-bucco-occlusal angles.

13. The shape of the occlusal surfaces of $\underline{6}$, $\underline{7}$, $\underline{8}$ is irregularly **rhombic** (Figs. 20, 21, 22). Draw three such figures and outline the occlusal surface of $\underline{6}$. $\underline{7}$, $\underline{8}$ one in each, showing differences in general shape of the surfaces of the three, the

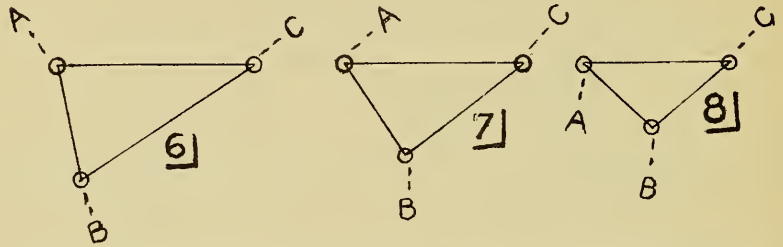


FIG. 23.—The molar triangle. Right upper first, second and third molars. *A* Entrance to mesio-buccal canal; *B*, entrance to disto-buccal canal; *C*, entrance to lingual canal.

difference in size of the disto-lingual lobe, location of the fifth cusp on $\underline{6}$ and shape of the angles. Indicate by letters the ridges, fossæ, lobes and grooves.

14. The entrance to the canals on the floor of the pulp chambers of upper molars is situated at the corners of an imaginary triangle known as the **Molar Triangle** (Fig. 23). Draw three triangles, one to represent each upper molar, right side, showing the difference in the shape and size of the triangles, due to diminution in the size of the teeth and change of location of the disto-buccal canal. Indicate by letters on the drawings the location of each individual canal.

15. Draw three cubical figures and place the mesial and distal roots of a lower molar at their bases (Fig. 24). Indicate

by letters the location of the surfaces, margins, line and point angles of a lower molar.

16. Draw and shade the buccal surface of $\lfloor\overline{6}$ and $\lfloor\overline{7}$, showing crown and roots (Figs. 25 and 26).

17. Draw and shade the mesial surface of crown and roots of $\overline{6}$ (Fig. 27).

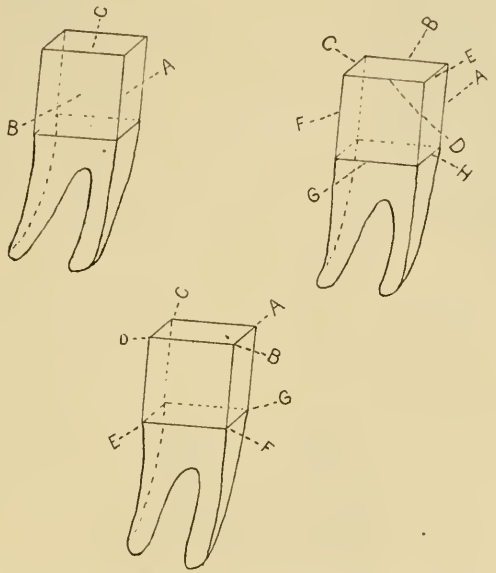


FIG. 24.—Diagrammatic drawing to show the surfaces and line and point angles on lower molars.

FIRST DIAGRAM.—*A*, Mesial surface; *B*, buccal surface; *C*, occlusal surface.

SECOND DIAGRAM.—*Line angles.* *A*, Mesio-lingual angle; *B*, occluso-lingual angle; *C*, disto-occlusal angle; *D*, bucco-occlusal angle; *E*, mesio-occlusal angle; *F*, disto-buccal angle; *G*, *H*, gingival line.

THIRD DIAGRAM.—*Point angles.* *A*, Mesio-linguo-occlusal; *B*, mesio-bucco-occlusal; *C*, Disto-linguo-occlusal; *D*, disto-bucco-occlusal; *E*, disto-bucco-gingival; *F*, mesio-bucco-gingival; *G*, mesio-linguo-gingival point angles.

18. Draw a **trapezoidal** figure, Fig. 28, and outline occlusal surface of $\lfloor\overline{6}$, indicating location of the ridges, grooves and lobes.

19. Draw a **parallelogram,** Fig. 29, and outline the occlusal surface of $\overline{7}\rfloor$, indicating the location of the ridges, grooves and lobes.

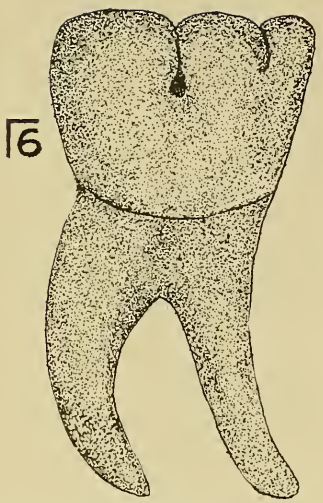


Fig. 25.—Left lower first molar. Buccal surface.

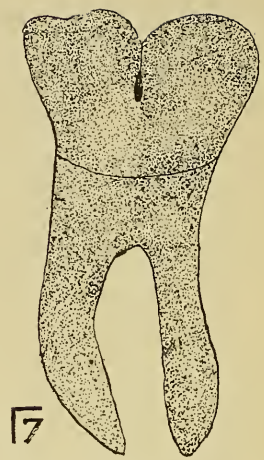


Fig. 26.—Left lower second molar. Buccal surface.

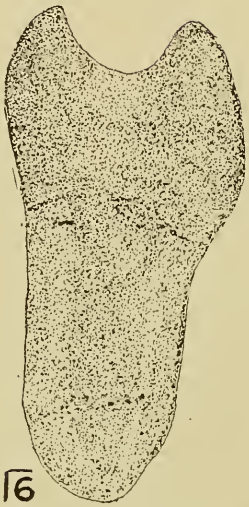


Fig. 27.—Left lower first molar. Mesial surface.

20. Draw the teeth of the upper and lower jaw in OCCLUSION, showing correct curvature of the line of occlusion, with its lowest point at the proper location, natural size (Fig. 30).

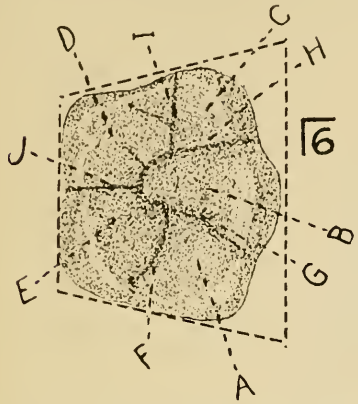


FIG. 28.—Left lower first molar. Occlusal surface. *A*, Mesio-buccal triangular ridge; *B*, disto-buccal triangular ridge; *C*, distal triangular ridge; *D*, disto-lingual triangular ridge; *E*, mesio-lingual triangular ridge; *F*, mesial groove; *G*, mesio-buccal groove; *H*, disto-buccal groove; *I*, distal groove; *J*, lingual groove.

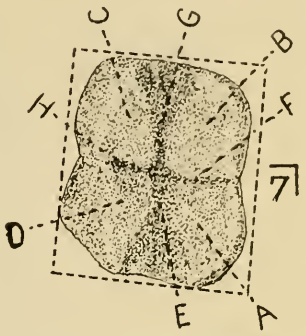


FIG. 29.—Right lower second molar. Occlusal surface. *A*, Mesio-lingual lobe; *B*, disto-lingual lobe; *C*, disto-buccal lobe; *D*, mesio-buccal lobe; *E*, mesial groove; *F*, lingual groove; *G*, distal groove; *H*, buccal groove.

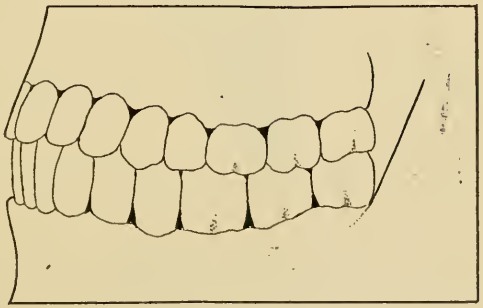


FIG. 30.—Occlusion of the teeth of the left side.

21. Make a drawing, side view, showing the proper inclination of the upper and lower anterior teeth (Fig. 31). The

uppers have a **labial** inclination, the lowers have a **slight labial** inclination or are occasionally **perpendicular.**

FIG. 31.—Inclination of the anterior teeth. Side view.

FIG. 32.—Mesial inclination of the upper central incisors.

22. Make a drawing, labial view, showing **mesial** inclination of these teeth (Fig. 32).

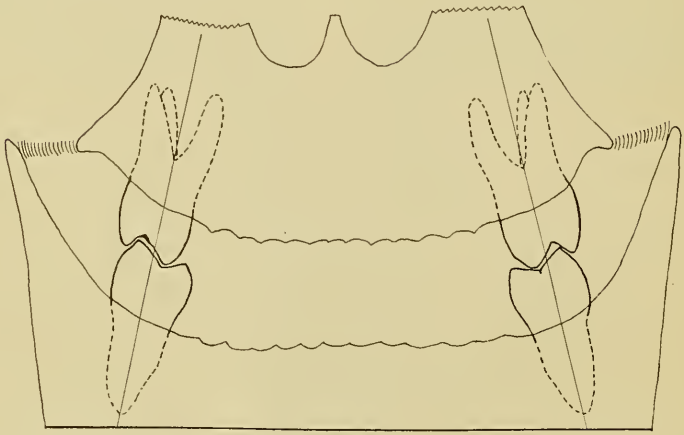


FIG. 33.—Diagrammatic drawing showing buccal inclination of the upper molars and lingual inclination of the lower molars.

23. Make a drawing, mesial view, showing general **buccal** inclination of the upper bicuspids and molars and general

lingual inclination of the lower teeth of the same denomination (Fig. 33).

24. Make a drawing of a longitudinal section of a central incisor, showing the enamel, dentin, cementum and pulp (Fig. 34).

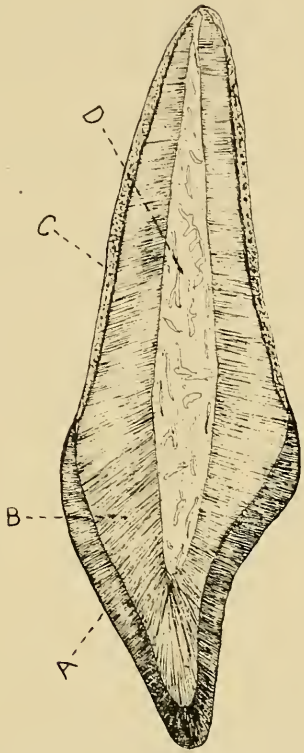


FIG. 34.—Upper central incisor. Proximal surface. *A*, Enamel; *B*, dentin; *C* cementum; *D*, pulp. (Diagrammatic.)

Modeling in Clay

The teeth are to be modeled to Black's measurements, enlarged five times. The rough molding to form is first done on the modeling board with the hands, when the finer

details are then brought out by means of the modeling tools. A natural tooth in front of the student serves as a guide.

Carving Teeth in Plaster

The denomination of the teeth and the number to be carved will be regulated by the time at the disposal of the student, in the discretion of the teacher. The technic of carving is practically the same as that described for *ivory teeth* and the student is referred to that section (page 27). The teeth are to be carved from plaster blocks to Black's average measurements, multiplied five times. The entire root should be carved. These teeth may be used later for technic work in cavity preparation.

Carving Teeth in Soap

The best soap for the purpose is Procter and Gamble's Ivory soap. This should be cut in blocks of proper dimensions, and laid out for hardening or seasoning for two weeks previous to the carving, otherwise it is too soft.

Carve all the teeth natural size, upper and lower of one side. The cuttings are made with a knife and wax spatula, the finer carving being done with the excavator or small chisel. The final polish may be put on by gently rubbing with the finger. The technic is the same as given under "Carving in Ivory," except that the cuttings are done with a knife, wax spatula, chisel and excavator.

Carving Teeth in French Chalk

French chalk.—Synonyms, Soap-stone, Talc Steatite. —Chemical composition, magnesium silicate.

Excellent carvings may be made from this material, which is of an olive-green, grayish or white color and easily obtained from drug-supply houses. The white variety is best for this purpose. It is readily sawed into blocks of convenient size and carved according to the technic given for carving in ivory. Its cutting consistence is much softer than ivory and harder than soap. The same instruments are used, the final polish being put on by rubbing with a smooth cloth.

Carving Teeth in Ivory

Ivory or bone blocks may be obtained for this purpose from the S. S. White Dental Mfg. Co., the Wenker Dental Mfg. Co. and Armour & Sons. Dr. Harper's, a set of six blocks, and Dr. Tenney's, a set of four, are also available. *Vegetable* ivory blocks are used as a substitute in some schools. They are not so hard as the ivory or bone block, and may be still further softened by saturation in water. The teeth to be carved are to be decided by the teacher.

Directions for Carving

Select a well-formed natural tooth. This is to serve only as a guide in the carving and not to be duplicated. The ivory carving is made to Black's measurements, with the *millimeter gauge* and on completion should be within 0.5 mm. of Black's measurements. For the lines of measurement, see page 10.

1. **Central Incisor.**—The instructions for carving the central will serve for any of the anterior teeth.

(a) With a blue pencil or ink, mark on the block the location, taken by means of the Boley gauge, of the future *contact points*, allowing 0.5 mm. excess for finishing down.

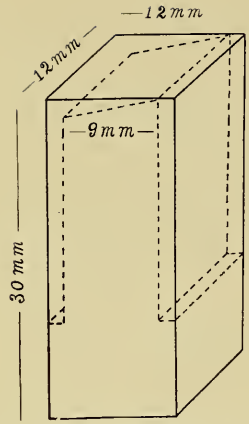


FIG. 35.—Marking and sawing the block to the future contact points and giving it the general slope of the cutting edge. Labial surface. The illustrations are not to scale.

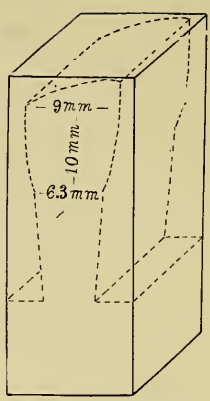


FIG. 36.—Outlining the cutting edge; measuring the length of the crown and the mesio-distal diameter at the neck; outlining the convexity of the proximal surfaces, filing to these marks and blocking out the root.

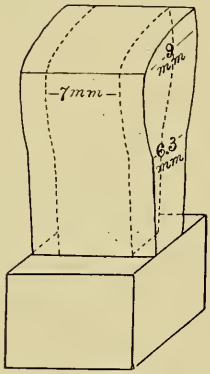


FIG. 37.—Taking the measurement for the greatest labio-lingual diameter and sawing the block to this dimension. Proximal surface.

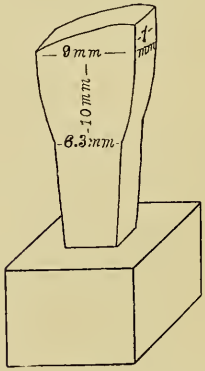


FIG. 38.—Block gradually assuming proper form.

(b) Saw the block down to these points.

(c) With the blue pencil, outline the future *cutting edge*

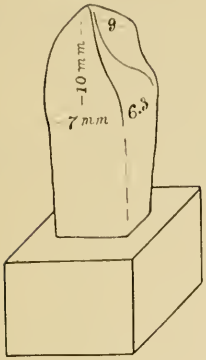


FIG. 39.—Filing the block on the mesial and distal sides to proper curvature of the labial and lingual surfaces.

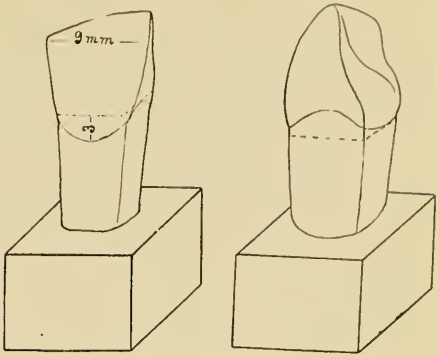


FIG. 40.—Outlining the curvature of the cervical line. Labial and proximal view.

with its proper slope toward the disto-incisal angle, and with the saw and vulcanite file trim the block nearly to this line, allowing 0.5 mm. excess for finishing (Fig. 35).

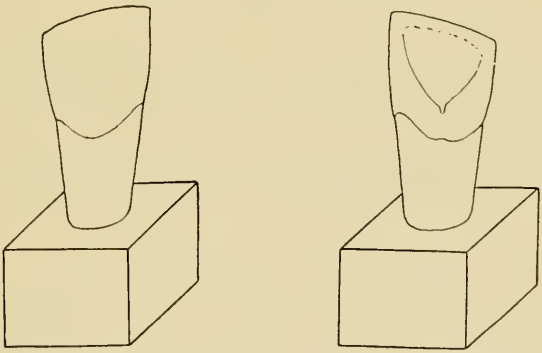


FIG. 41.—Carving complete. Labial and lingual view.

(d) With the millimeter gauge, measure the *length of the crown* from the cutting edge to the future cervical line on the

NOTE.—The drawings illustrating the method of carving were made by student E. W. Niederhofer, class of 1915, Ohio College of Dental Surgery.

labial surface, and mark the location of the cervical line (gingival, Black) with the pencil.

(e) Mark the location, taken by means of the Boley gauge, of the future *mesio-distal diameter of the neck* of the tooth. Then outline the *convexity of the mesial and distal surfaces* by drawing a line from the contact points to these marks.

(f) With the file trim the blocks on the mesial and distal sides nearly to the marks made in "e," giving these sides the proper convexity, *the distal side being more convex.* The cuttings may be carried a distance of half way up the future root of the tooth (Fig. 36).

(g) With the Boley gauge take the measurement for the

FIG. 42.—Carvings in ivory.

greatest *labio-lingual* diameter, which will be at the gingival ridge, and mark it on the mesial and distal sides of the block (Figs. 37 and 38).

(h) Now, holding the block on its mesial or distal side, outline with the pencil the *curvature of the labial and lingual surface* from the cutting edge to the cervical line.

(i) File to shape, carrying the labial and lingual cuttings a distance of half way up the future root. The apical half or third of the root is not carved, leaving the end of the block untouched (Fig. 39).

(j) To outline the *curvature of the cervical line*, find the proper measurement from the "Table of Measurements" and mark the length of curvature by means of the millimeter gauge

on the labial surface; then draw a straight line from this point to the mesial and distal surfaces, which will then give the extent of the curvature (Fig 40).

(k) Bring all the cuttings down to proper measurement, and do the finer carving with the file, scraper and small chisels and excavators, representing the marginal and gingival ridges, grooves, cervical line and all other points (Fig. 41).

(l) Finish with sandpaper of increasing fineness, and then with pumice and whiting on the lathe (Fig. 42).

2. **Bicuspid and Molar.**—Practically the same directions are followed. First mark the contact points and saw or trim not quite to them. Repeat the same procedure for the bucco-lingual diameter. Then measure for the length of the crown on the buccal, lingual, mesial and distal sides, after which outline with the pencil the proper contours and saw or file to them, finally extending the cuttings the desired length and shape. Then complete the surface markings, such as ridges, grooves and cusps, as well as the cervical line, with the scraper and chisels and excavators, completing the work with sandpaper, pumice and whiting.

If desired and time permits, the teeth of the upper and lower jaw, right or left side, may be carved and then mounted in occlusion on hard or soft rubber jaws as suggested by Dr. A. E. Webster. If this is done, all the teeth should be modeled after a definite type, as sanguine, bilious, nervous or lymphatic. They may then be later used for the technic exercises in cavity preparation.

Sawing and Filing Sections

The **object** of cutting sections is to give the student familiarity with the cutting consistence of natural tooth structure, to familiarize him with the thickness of enamel, dentin and cementum, together with their relations to each other, and to expose the pulp chamber and canals for purposes of study.

1. **Longitudinal Sections.**—Make one section by means of the file from the labial, buccal or lingual, and one from the mesial or distal aspect of the teeth selected by the teacher.

2. **Transverse Sections.**—Make by means of the saw a transverse section at the cervical line and another at mid-root of the upper and lower teeth selected.

Directions.—(1) *For the Longitudinal Sections.*—(a) Fix the tooth on the wood block by means of melted sealing wax

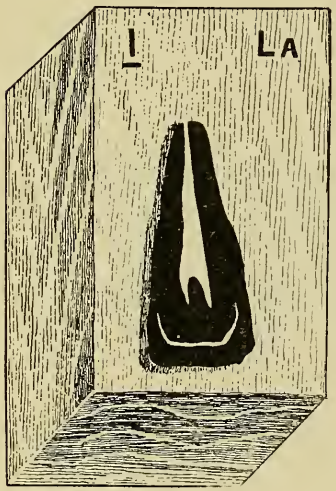


Fig. 43.—Longitudinal section of the upper central incisor, labial aspect, mounted and annotated.

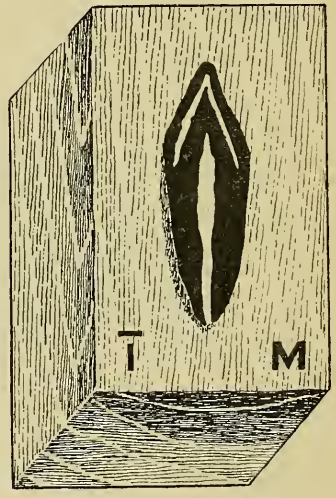


Fig. 44.—Longitudinal section of the lower central incisor, mesial aspect, mounted and annotated.

and a wax spatula. For sections showing the **labial** or **buccal** aspect of the chamber and canals, mount the tooth with the **lingual** surface facing up. For those showing the **mesial** or **distal** aspect, mount the *opposite* surface facing up. (b) Fix the block securely in the bench vise and file longitudinally at an angle of 45 degrees until the pulp chamber is exposed. (c) Then insert a smooth broach into the chamber and carry it the full length of the canal through the apical foramen. File until

the broach is exposed full length. Then, removing the broach, clear out the contents of the chamber and canals and render clean and smooth so that a good clear-cut print may be made later (Figs. 43 and 44).

(2) *Transverse Sections.*—(a) Mount the tooth longitudinally on the block by means of sealing wax. (b) Fix in the vise, and, with the saw, make a transverse section at the neck and another at mid-root, thus cutting the tooth into three

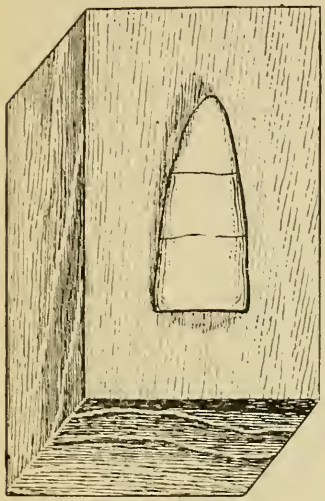


FIG. 45.—Tooth mounted on a wood block and sawed into three sections.

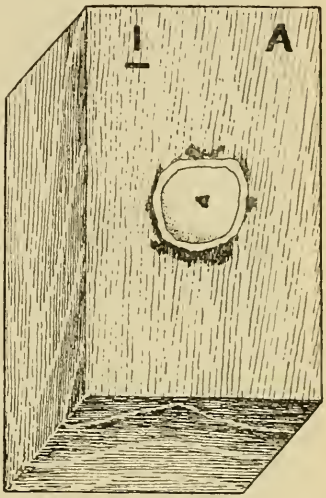


FIG. 46.—Gingival section of an upper central incisor, mounted and annotated.

sections. (c) Clear out the contents of the chamber and canals with broaches and excavators, rendering the margins distinct and clear for making prints later (Figs. 45, 46, 47 and 48).

(d) *Mounting the Sections.*—Mount the section permanently on the block by covering the face of the block with melted sealing wax, building it up so as to elevate the section from the block if so desired. Smooth the wax with a spatula

and put on a high, smooth finish with a mouth blowpipe. The margins of the section should extend slightly above the level of the sealing wax so as not to interfere later with the making of a good print.

(e) *Cutting the Relief Line.*—With a small wheel bur or chisel cut a relief line on the longitudinal section at the junction of the enamel and dentin, removing the *stratum*

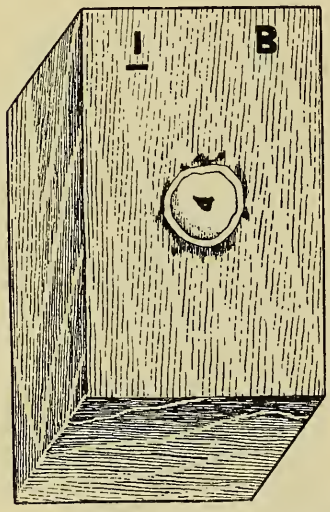


Fig. 47.—Mid-root section of an upper central incisor, mounted and annotated.

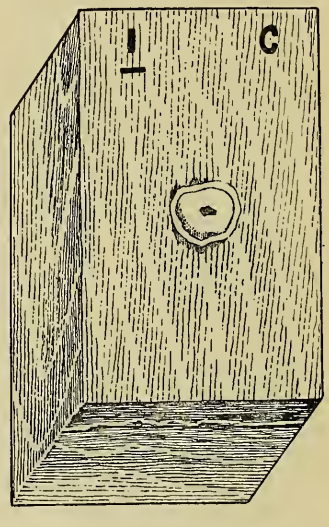


Fig. 48.—Apical third section of the upper central incisor.

granulosum and thus bringing out the thickness of the enamel cap.

(f) *Finishing.*—Smooth the entire exposed surface of all the sections with fine sandpaper.

(g) *Labeling or Annotating the Sections.*—For the upper *longitudinal* sections, mark the notation, as 1, 2, 3 in the upper *left-hand corner* and the aspect presenting to view as La., Li., Bu., in the upper *right-hand corner* (Fig. 43). For the lowers place them in the *lower* left- and right-hand corners respec-

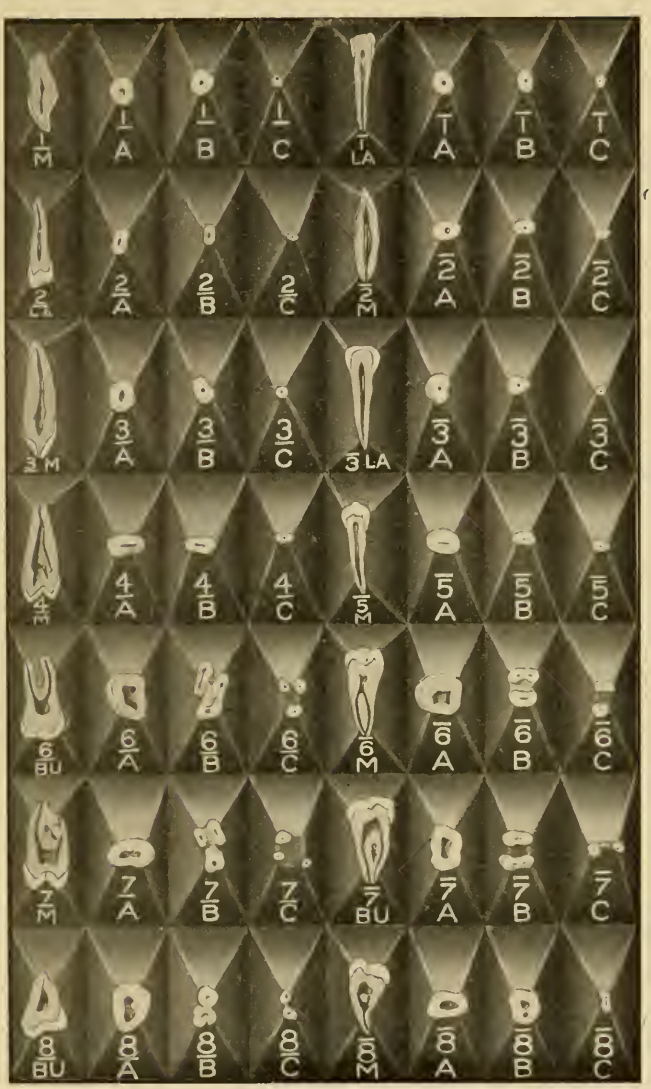


FIG. 49.—A method of mounting and annotating a box of fifty-six longitudinal and transverse sections. The face of the wood block is covered with sealing wax, which is modeled to form with a wax spatula and polished by heating with a mouth blowpipe.

tively (Fig. 44). In this way the denomination of the tooth and the aspect presenting to view may be seen at a glance. For the transverse sections the same plan is followed in regard to the denomination of the tooth. Also label the block in the upper or lower right-hand corner, depending on whether the tooth is upper or lower, A, B, or C, thus indicating whether it is the *crown*, *mid-root* or *apical* section; A representing the crown, B the mid-root, and C the apical portion (Figs. 46, 47, 48).

Making Prints or Silhouettes

Object.—To further impress upon the student's mind the size, location and shape of the pulp chamber and canals, the outline form of the tooth and the relative thickness of the enamel and dentin.

Directions.—The prints are made on ruled paper, as in the illustration, Fig. 50, from the sections already made. The face of the section must be perfectly smooth and the enamel line and chamber and canal margins clearly cut, if good prints are desired.

(a) Ink the surface of the section by bringing it in contact with the ink pad. Avoid too much ink.

(b) Stamp the section firmly in contact with the note paper, and hold steadily for a few moments to allow the ink to take hold of the paper. In *curved sections* great care is necessary to bring every portion of the section in contact with the paper. Several thicknesses of the paper may be held in the palm of the left hand while stamping with the right hand; or laying the paper on a soft rubber pad of about 1/4 inch in thickness and carefully rotating the section longitudinally is a valuable procedure in these cases.

(c) Annotate the prints in the same manner as described for the sections (Fig. 50).

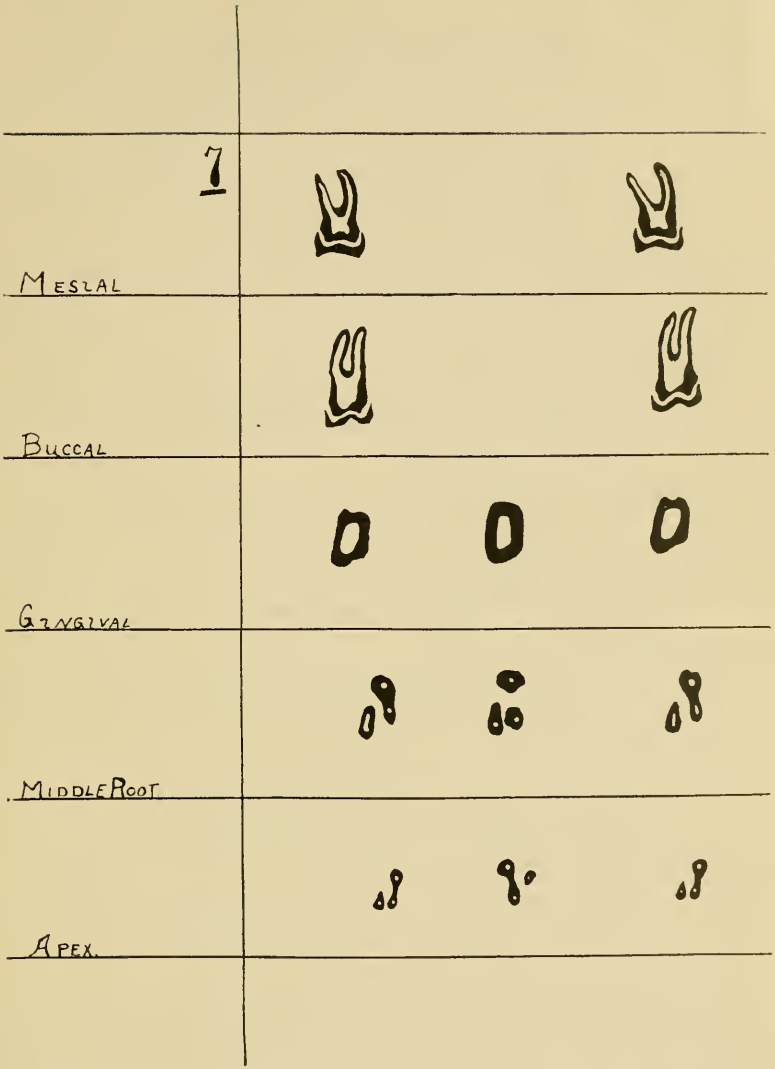


FIG. 50.—A page from a book of prints, showing longitudinal and transverse views of the pulp-chambers and canals of the upper second molar.

REVIEW QUIZ

1. Give the **definition of a human tooth.**

Answer: One of thirty-two specialized organs, situated in the alveolar process of the upper and lower jaws, designed for purposes of mastication, to assist in articulate speech and to regulate facial contour.

2. Define **angle** and distinguish between **line** and **point** angle.

3. Define **fossa** and give location and names of the **fossæ** on incisors and molars.

4. Define **lobe** and distinguish between **lobe** and **cusp.**

5. Define **ridge** and name the **marginal ridges** on incisors, cuspids, bicuspids and molars.

6. Describe the location of the **transverse ridge** on bicuspids.

7. Describe the location of the **oblique ridge** on molars.

8. Describe the location of the **triangular ridge** on bicuspids and molars.

9. On what teeth are **supplemental ridges** most frequently found?

10. Describe the location of the **developmental grooves** on incisors, cuspids, bicuspids and molars.

11. On what teeth are **supplemental grooves** most frequently found?

12. Name the **sulcate grooves** on cuspids, bicuspids and molars.

13. Define **groove, sulcus, fossa.**

14. Name the **roots** of upper bicuspids, upper molars and lower molars.

15. Name the **canals** in the same teeth.

16. Distinguish between **fossa** and **pit.**

17. Name the **pits** on bicuspids.

18. On what part of incisors are **pits** most frequently found?

19. Define **axial plane; horizontal plane.**

20. Give another name for **cornua.**

21. Describe the **horns** of the pulp in incisors, cuspids, bicuspids and molars.

22. What conditions regulate the size of the cornuæ?

23. Give the **derivation** of the word "*incisor.*"

24. Define the term "*succedaneous*" and name the **succedaneous teeth.**

25. Name the chief **points of difference** between the upper central and lateral incisors.

26. Name the chief **points of difference** between the upper and lower incisors.

27. Describe the **form** of the roots and root canals, on section, of the anterior teeth, upper and lower.

28. Describe the **form** of the roots and root canals, on section, of the upper and lower bicuspids.

29. Describe the **form** of the roots and root canals, on section, of the upper and lower molars.

30. Define the term **"cingule"** and give its most frequent location.

31. Define the term **"axial."**

32. Name the **surfaces** of all the teeth.

33. How are surfaces named?

34. Define **proximal surface.**

35. Define **median line.**

36. Distinguish between **line** and **plane of occlusion.**

37. Describe the difference in the **facial angle** of the Caucasian and Negro or mixed races.

38. Is the upper or lower **arch** the larger?

39. Describe the mesio-distal **occlusion of the teeth** beginning at the median line.

40. **With the teeth in occlusion,** describe the relation of the incisal edges of the upper and lower anteriors and the buccal and lingual cusps of the upper and lower bicuspids and molars.

41. Define **inclination** of the teeth.

42. Describe the inclination of all the teeth.

43. Describe the **interproximal space.**

44. Describe the **interproximal embrasure.**

45. What is the average **measurement of the arch** in inches?

46. Give the total measurement of all the **teeth at the necks.**

47. What is the average aggregate **measurement of the interproximal spaces?**

48. Under normal conditions, what tissues occupy the interproximal spaces?

49. Give the **formulæ** for the permanent and temporary teeth.

50. Write the **notation** for the following permanent teeth, viz : right upper central, left upper lateral, right lower cuspid, left lower first bicuspid, right upper second molar, left lower third molar.

51. What teeth are indicated by the following notations, viz.: $\lfloor \underline{1}, \underline{2} \rfloor, \lceil \overline{1} \rceil, \lceil \overline{3}, \overline{5} \rceil, \lfloor \underline{6}, \overline{6} \rfloor$?

52. Write the **notation** for all the temporary teeth.

53. Define **secondary dentin** and tell where and when it is found.

54. Describe the **pericementum** and give another name for it.

55. Define **rugæ.**

56. Define **gingiva** and give plural.

57. Define **frenum labium superioris, frenum labium inferioris** and **frenum linguæ.**

CHAPTER II

INSTRUMENTS AND APPLIANCES

In order that the student may be enabled to grasp the subject matter of the following chapters, intelligently perform the various technic operations to be later outlined, and equip himself for clinical work in his junior year, a thorough knowledge of instruments and appliances, their names and uses, is essential. It is necessary that he be grounded in the metallurgical properties of steel, from which most of these instruments are made, know their methods of construction and practise the proper instrument grasps, rests and guards.

The following is intended only as a brief review of the working properties of steel. It is taken for granted it will receive full attention in the metallurgical laboratory.

STEEL

Definition.—An alloy capable of being hardened, softened and tempered, made by the addition of a small percentage of carbon to iron; melting point variously estimated at from 1500–1600° C.

Soft steel contains 0.5 per cent. or less of carbon. **Hard steel** contains from 0.5 per cent. to 1.5 per cent. of carbon.

Steel of an extreme degree of hardness, containing a large percentage of carbon, is utilized for making dental cutting instruments.

Hardening Steel.—Ordinary steel may be hardened to its limit by heating to a *full cherry red* color and immediately plunging in *cold* water. In this state it is extremely brittle.

The more carbon it contains, the harder and more brittle it becomes.

Tempering Steel.—By tempering steel is meant the process of rendering it softer, tougher and less brittle. It is accomplished by heating to a *lower temperature* than that used for hardening steel, and then plunging in *cold salt water, slightly acidulated water, oil* or *mercury.* Oil gives a tougher temper than water, while mercury gives an extreme degree of toughness. Hard steel is capable of much more temper than soft steel.

Annealing Steel.—The operation of reducing it to its extreme degree of softness. This is accomplished by heating to *dull* or *"incipient" redness* and **cooling slowly.** A greater degree of softness is produced by covering with sand, plaster or pumice, thus excluding the atmosphere, heating and allowing to cool while so covered.

In the manufacture of dental instruments, hard steel (that containing a high percentage of carbon) of a higher or lower degree of temper is required, depending upon the purpose for which the instrument is intended. The following table shows the approximate temperatures, with the corresponding colors produced, to which instrument steel is carried in the making of various instruments:

Temperature	Color	Use
217° to 232° C.	light yellow	enamel chisels, burnishers.
243° C.	medium yellow	excavators, scalers.
258° C.	brown-yellow	pluggers.
266° C.	brown-purple	saws, shanks of instruments.
279° to 299° C.	blue	spring temper.

Technical Exercises in the Working of Steel

1. **Making Smooth Broaches and Canal Explorers.**—Cut piano wire of the desired gauge to the required length and

file to a point with a long taper; or utilize old, worn pulp canal cleansers for the same purpose by filing off the barbs and reducing to the desired size and taper. Remove file marks and polish with emery paper. These may be later used in the technic course as canal explorers and dressers. The points of those intended to be used for explorers and for placing cotton dressings in canals, where they are to be left temporarily, should be filed to a *sharp point*. Cotton, wrapped around a broach of this kind, has a natural tendency to come off. Those intended for swabbing and drying the canals, where it is desired to withdraw the cotton with the broach, should have their ends cut off *square*, with a pair of scissors, when it will be found that, when wrapped with cotton, they will retain it very readily.

2. **Making Hooked Extractors.**—Place the point of a piano wire broach (as made in No. 1) on an anvil. Lay the sharp blade of a knife 1/8 inch from the end, with the edge of the blade pointing toward the shaft of the broach. Elevate the shaft of the broach, when the hook may be made at either a right, acute, or any desired angle, depending on the degree of elevation of the shaft. File the point to the desired length and sharpness. Polish as before.

3. **Exercises to Illustrate Annealing, Hardening and Tempering:**

(a) **Annealing.**—(1) Place a few smooth broaches on a plate of iron, heat to **"full cherry" redness** and allow to cool slowly. (2) Cover a few more with plaster, pumice or sand, heat to **"full cherry" redness** and allow to cool slowly. Note the difference in result accomplished by the two procedures. (3) Heat the small end of an excavator blank to **full cherry redness** and allow to cool slowly.

(b) **Hardening.**—Coat an excavator blank with soap to prevent overheating and burning out of carbon. Heat to **full**

cherry redness and plunge in cold, slightly acidulated or salt water, oil or mercury.

(c) **Tempering.**—(1) Heat the shank and blade-end of the same excavator blank to **cherry red** and plunge immediately in any of the above media. Polish on the lathe to remove the oxides, which have accumulated on the surface. Test with a file to ascertain if full hardness has been produced. (2) If so, pass in the flame again and heat the blade-end to a **medium yellow color;** plunge immediately (thus tempering the blade-end), after which again polish to remove the oxides. (3) Place the small end in contact with a hammer to prevent drawing the temper at the point, apply the flame back of the shank and heat to a **blue color** (spring temper), immediately plunging in oil, thus tempering the shank.

INSTRUMENTOLOGY

Parts of an Instrument.—Instruments may be divided into those intended to be used by hand—**Hand Instruments**—and those for use in the dental engine—**Engine Instruments.** Most instruments consist of three parts, viz., (1) *Handle or Shaft,* (2) *Shank,* and (3) *Blade or Nib.* The *Handle or Shaft* is that part which is grasped by the hand in using (Fig. 51). The *Blade* is the cutting part of cutting instruments, while the working part of pluggers is known as the *Nib.* The *Shank* is the part connecting the handle or shaft with the blade or nib. The taper from handle to blade is to impart proper balance to the instrument and to give shape, lightness of touch and delicacy of manipulation. Most modern hand instruments in dentistry are intended for delicate manipulation and require small handles, while some others are used for heavier work and should have larger handles. The rule in selecting handles is, the more delicate the work intended to be performed the

smaller the handle and vice versa. Handles, whenever possible, should be of steel on account of convenience in sterilizing (Fig. 52).

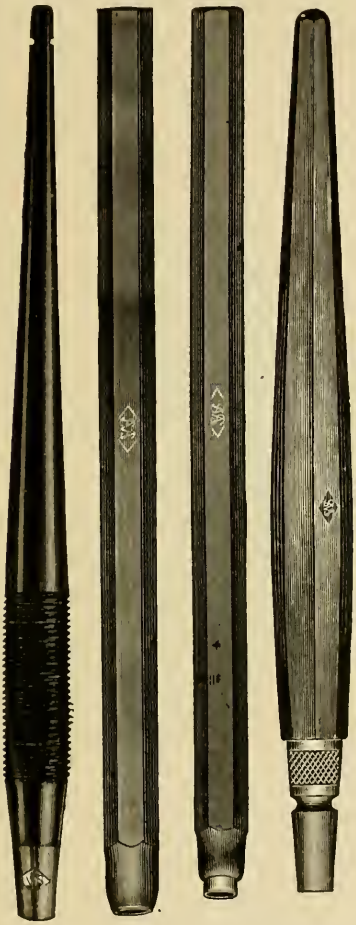


FIG. 51.—Vulcanite instrument handles.

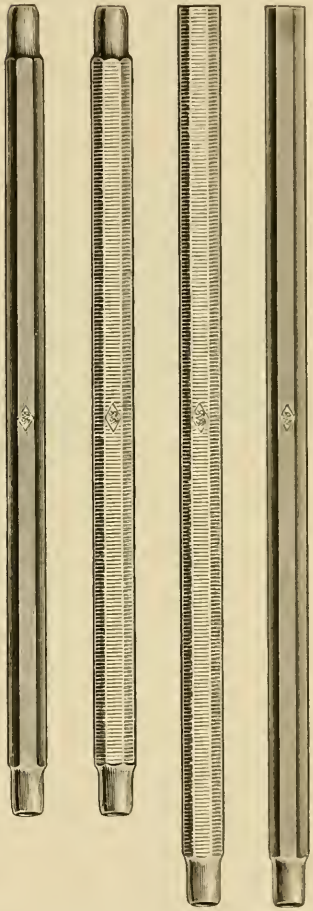


FIG. 52.—Steel cone-socket instrument handles.

Angles in Shanks.—The shank of an instrument may be straight or bent at various angles for better balancing of the instrument and to carry the blade or working part into

inaccessible places. Dr. Black has classified instruments into (1) *Mon-angle*, (2) *Bin-angle*, (3) *Triple-angle*, and (4) *Quadrangle*, depending on whether they have one, two, three, or four angles in the shank.

Contra-angles.—For better balancing and in order to bring the blade as near as possible in a direct line with the long axis of the shaft, the shanks of instruments are also contra-angled. This variety of instrument has a less tendency to turn in the hand when being used, and consequently will do better work with less strain on the operator. Contra-angle instruments are divided into (1) *Bin-angle Contra-angles*, (2) *Triple-angle Contra-angles*, and (3) *Quadrangle Contra-angles*, depending on whether there are two, three or four bends in the shank of the instrument. A well-balanced instrument should be so contra-angled as to bring its working point within 2 millimeters of the long axis of its shaft. For example of angles in instrument shanks see Fig. 61.

Instrument Grasps.—As soon as the student begins to handle instruments, he should learn the proper grasps. Proper instrument grasps lead to proficiency in the performance of dental operations, and should be thoroughly studied and practised if the best results are to be obtained. Carelessness in this respect will lead to bad habits which may cling throughout life. The three principal grasps are (1) The *Pen Grasp*, (2) The *Inverted Pen Grasp*, and (3) The *Palm and Thumb Grasp*. There are other grasps which are occasionally used, but as they are of minor importance they will not be described.

(1) The **Pen Grasp** is most frequently used and is the one intended for great delicacy of touch. The instrument is held, as the name indicates, like a pen in writing, except that the shank should be in direct contact with the pulps of the thumb and first and second fingers. With practice, this gives great

power, facility, delicacy and range of movement. The second finger should not be allowed to crawl under the shank toward the finger-joint, as seen with some operators, thus limiting the range of movement and lessening the power of the thrust (Fig. 53). A modification of the pen grasp is seen in Fig.

Fig. 53.—The pen grasp, the rest and the guard.

220, where the instrument is held between the balls of the thumb and first finger.

(2) The **Inverted Pen Grasp** is similar to the pen grasp except that the position of the instrument is reversed, so that the working part points toward, instead of away from, the hand. This grasp is only used occasionally. Fig. 219 shows a modification of the inverted pen grasp. The position

of the second finger is incorrect, as the instrument should lie against the pulp of the second finger.

(3) **The Palm and Thumb Grasp** is the grasp of power, and is accomplished by placing the instrument in a position similar to the one utilized in whittling a piece of wood, the handle, resting in the palm of the hand, being grasped by the four fingers, while the thumb rests on some adjoining surface (Fig. 54).

The strength of the thrust is largely influenced by the

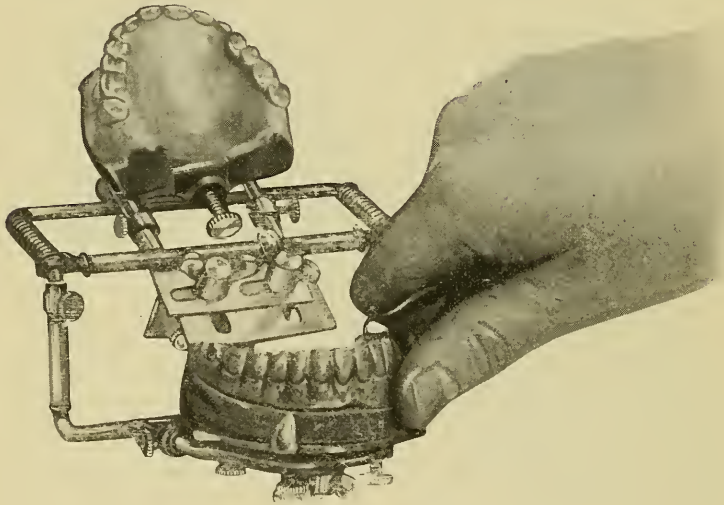


FIG. 54.—The palm and thumb grasp.

proper use of the grasp and may be markedly increased by frequent exercise.

Rests and Guards.—While maintaining the proper instrument grasps, it becomes necessary to steady the *right hand* during the performance of the operation, in order that the instrument may be securely held to its work without slipping. In the case of the pen and inverted pen grasps this is accomplished by resting the fourth or fifth or both fingers on the tooth operated upon, or on some adjoining

tooth, or surface. The steadying of the hand is accomplished, when the palm and thumb grasp is assumed, by means of the thumb, resting it on some convenient location. This position of the fingers or the thumb is known as **The Rest** (Fig. 53). **The Guard** is the position assumed by the thumb and forefinger of the *left hand* to steady the parts operated upon and protect them from injury, in case of accidental slipping of the instrument (see Fig. 53). The thumb is placed

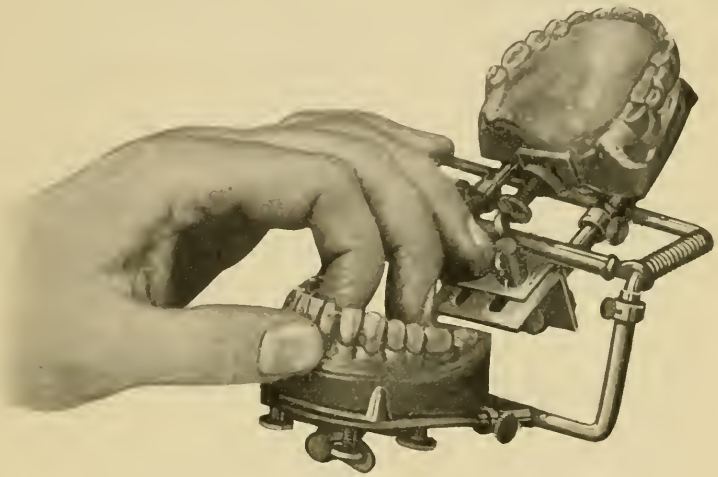


FIG. 55.—The guard.

on one side of the tooth operated upon and the forefinger on the other, the position being reversed, depending on the location of the operation (Fig. 55). The practice of the proper rests and guards is important and should receive close attention in the technic laboratory at the same time that the study of instrument grasps is begun.

The Metric System of Measurement

Before taking up the study of instrument forms and their manufacture, it is necessary for the student to have a knowl-

edge of the metric system of linear measurement and the centigrade circle, together with their method of adaptation to the taking of the measurement of the various parts of instruments.

The metric or *French decimal* system is the one now adopted by most scientific men and the student should begin at once to put its principles into use. It is based on the French meter, which equals 39.37 inches in the old measurement. The denominations of the system may be learned here, but the only method of thoroughly appreciating them is to put them into actual practice. These denominations, so far as their uses in dentistry require, are as follows:

One Meter	39 inches	(approximate)·
One Decimeter (one-tenth of a meter)	4 inches	(approximate)·
One Centimeter (one-hundredth meter)	2/5 inch	(approximate)·
One Millimeter (one-thousandth meter)	1/25 inch	(approximate).

Tenths, hundredths and thousandths of a millimeter.

One thousandth of a millimeter is known as a micron and is used only in microscopic work.

(Table from Black's Operative Dentistry.)

The Centigrade Circle.—This is a circle divided into one

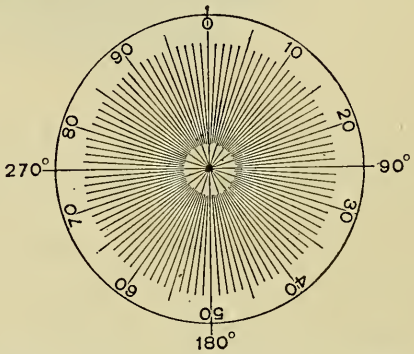


FIG. 56.—The centigrade circle. 25, 50 and 75 centigrades equal respectively 90, 180 and 270 astronomical degrees.

hundred parts or degrees, instead of 360°, as is the astronomical circle. To convert centigrades, the degrees represented

in this circle, into astronomical degrees, multiply 360 by the number of centigrades and divide by 100; or (a simpler method) after multiplying, cut off two figures (move the decimal point two figures to the left) as in calculating interest (Fig. 56).

COMPARISON OF CENTIGRADE ANGLES WITH ASTRONOMICAL DEGREES (TABLE FROM BLACK)

6 centigrades	21.6 degrees
12 centigrades	43.2 degrees
18 centigrades	64.8 degrees
23 centigrades	82.8 degrees
28 centigrades	100.8 degrees
80 centigrades	288.0 degrees
95 centigrades	340.0 degrees

The Dental Instrument Gauge

The millimeter measure and the centigrade circle have been combined in an instrument known as the Dental Instrument Gauge. This appliance is largely used by instrument manufacturers for measuring the length, width and angle of the cutting edge of the blade and the angles in the shank of the instrument; but its cost is almost prohibitive for general use of dental students. For measurement of angles in the technic work, in fact, for taking any measurements desired, good results may be

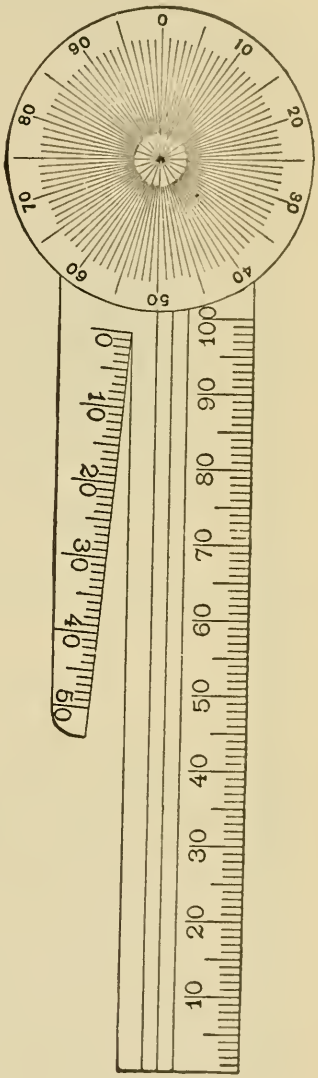


FIG. 57.—Dental instrument gauge.

accomplished on the illustration here given if the instrument is not at hand (Fig. 57).

1. **To measure the width of the blade** lay it in the small slot numbered from 0 to 50, which will give the width in *tenths of a millimeter.*

2. **To measure the length of the blade** lay it lengthwise in the gradations on the principal bar and measure from the cutting edge to the first angle in the shank, which will give the length in *millimeters.*

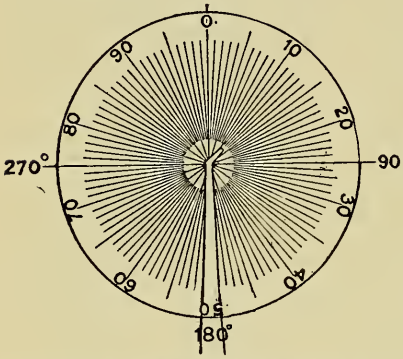


Fig. 58.—Measuring the angle of the blade with its shaft. (American Textbook of Operative Dentistry.)

3. **To measure the angle of the blade with its shaft** lay the handle or shaft on the main bar of the gauge and parallel with the lengthwise lines, having the blade turned toward the small numbers to the *right;* while holding it so, bring the length of the blade parallel with one of the gradations of the circle, which will give the angle in centigrades (Fig. 58).

4. **To measure the angle of the cutting edge of the blade with its shaft** lay the instrument in the same position as described in 3, and, without rotating it, move it to the left (keeping its shaft parallel with the lengthwise lines on the main bar of the gauge), until the angle of the blade is parallel with one of the gradations to the *left* of the circular head. This measurement is seldom necessary, as in most instruments the cutting edge is at right angles to the length of the blade. Occasionally, though, variations are found, as in Black's Gingival Trimmers and in some varieties of chisel.

5. **To measure the amount of bevel of a blade** place

the edge of the blade in the center of the circle, with one side of the blade on the zero division. The figure on the periphery of the circle on the line which follows the other side of the blade will give the amount of bevel in centigrades. The first two measurements here given are the only ones in the list of which the *Boley gauge* is capable.

Formula Names.—Dr. G. V. Black's set of instruments is designed largely after the first three methods of measurement given above, and the measurements are placed on the shafts of the instruments in the order given, the first measurement representing the width of the blade in tenths of a millimeter, the second representing its length in millimeters, and the third the angle of the blade with the shaft. In cases, however, where the fourth measurement, as described above, is necessary, it is placed second in the formula, the entire set of measurements being known as the *Formula Name* of the instrument (Fig. 59).

Fig. 59.—Hatchet excavator showing formula on the handle. Figure 1 on the end of the handle is the catalogue number.

The Boley Millimeter Gauge

This instrument is sufficient for measuring all but the angles in the blade and shank of an instrument. The smaller gradations on the gauge are millimeters. The instrument is capable of measuring as much as 10 millimeters (1 centimeter) or as little as 0.1 millimeter (1/250 inch). For measuring in tenths of a millimeter a small scale known as **the Vernier,** located on the sliding piece by which the jaws of the instrument are opened, is used. On examination of the

instrument, it will be seen that the divisions of this short scale (the Vernier) equal 9 divisions on the main scale. When the zero divisions on the main scale and the Vernier are together, the instrument is at rest and is not capable of registering a measurement. Now, move the *first* division on the Vernier in contact with the *first* division on the main scale and the instrument will register 0.1 millimeter; move the *second* divisions together and 0.2 millimeter are registered; the *third* divisions giving 0.3 millimeter, the *fourth* divisions giving 0.4, the *fifth* divisions giving 0.5, and thus continuing until 1 millimeter is registered. The Boley gauge is valuable for measuring instrument blades, plugger points, drills, burs, differences in the measurement of teeth of the same denomination in the mouth, in comparing measurements, in restoring angles of teeth in gold-building operations, in selecting artificial teeth, and many other cases arising in

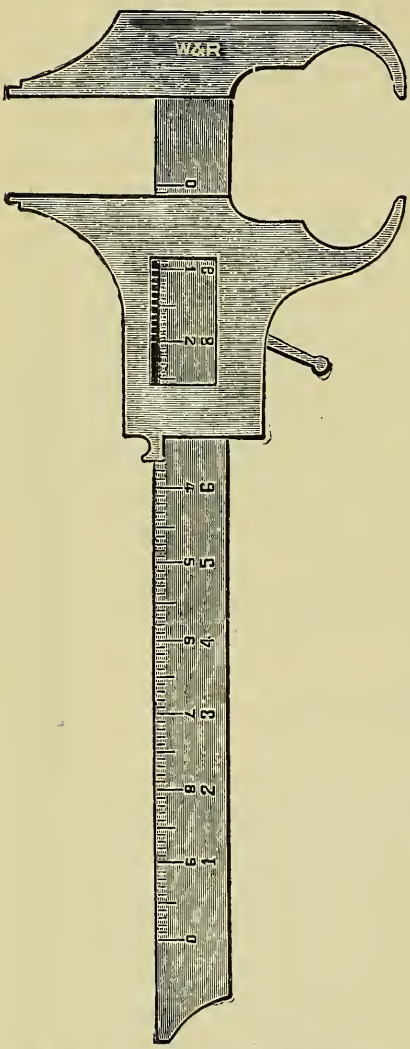


Fig. 60.—Boley millimeter gauge.

dental practice. It should be in the hands of every dental student and practitioner (Fig. 60).

Instruments are known as **Long-handle Instruments** if the handle, shank and blade are all made from one piece of steel; if the shank and blade or nib are separate from the handle and intended to be screwed into it, the instrument is known as a **Cone-socket Instrument.** Examples of long handle instruments are shown in Fig. 71, while the Black set of pluggers seen in Fig. 86 are of the cone-socket variety. The *advantage* in the cone-socket instrument is that, if the working part is broken, it may be replaced at less expense; the *disadvantage* is its tendency to loosen at the joint. *Students should see that all cone-socket instruments are screwed tight into the handles before using.*

Bevels.—The blades of some cutting instruments, such as chisels, are beveled on only one side, while others, such as Hatchet Excavators, are **bi-beveled,** that is, beveled on both sides (see Figs. 61 and 62).

Rights and Lefts.—Instruments are frequently made in pairs, the angles in the shank throwing the working point of one to the right and of the other to the left, both instruments being intended to do the same character of work on opposite sides of a cavity or the mouth. These are known as **Rights and Lefts.** Familiar examples are spoon excavators and various hand-pluggers. See Fig. 61—Spoons 10, 6, 12 L; 10, 6, 12 R.

Names of Instruments.—The names of instruments are classified as follows:

1. *Order Names.*—These names denote the purpose for which the instrument is intended, as excavator, plugger, chisel, drill, mallet.

2. *Sub-order Names.*—These define the manner or position of use of the instrument; as automatic mallet, hand plugger, pull scaler, bicuspid clamp.

3. *Class Names* describe the working point of the instrument; as hatchet excavator, spoon excavator, round bur, inverted cone bur, serrated plugger.

4. *Sub-class Names* indicate the shape of the shank; as Mon-angle, Bin-angle, Triple-angle, Contra-angle.

These names are frequently combined in the description of instruments, as Mon-angle Hatchet Excavator, Gingival Margin Trimmer, Triple-angle Contra-angle Spoon Excavator.

CLASSIFICATION OF INSTRUMENTS

For purposes of description, instruments may be divided into (1) Cutting Instruments, (2) Condensing Instruments, (3) Miscellaneous Instruments. A brief description of each class follows:

1. **Cutting Instruments.**—Definition: Instruments for the cutting of the hard and soft tissues of the mouth, removal of deposits from the teeth, and for finishing fillings.

(a) Excavator
(b) Chisel
(c) Bur
(d) Drill
(e) Reamer
(f) Lancet
(g) Scaler
(h) File
(i) Saw
(j) Knife
(k) Wheel
(l) Point
(m) Disk
(n) Strip

(a) **Excavator.**—An instrument for the excavation and removal of decay and the shaping of the internal parts of cavities. There are five forms, viz., the *hatchet*, the *hoe*, the *spoon*, the *discoid* and the *cleoid*. Their names indicate their form, they being designed after the ordinary hatchet, hoe, spoon, etc. (Fig. 61).

The *hatchet excavator* (Fig. 61; 12–5–12) has the edge of the blade running in a direction parallel with the handle, and

is *bi-beveled.* In the *hoe excavator* (Fig. 61; 8–3–23) the edge of the blade is beveled on the side distal (away from) to the shaft and runs at right angles to it. The hatchet and hoe are used for the removal of the harder varieties of decay and to give form to the internal parts of cavities. The *spoons* (Fig. 61; 10–6–12) and *discoids* (round spoons) are intended especially for the scooping out of soft decay, and are beveled only on the distal (far) side. *Cleoid* means claw-like, the instrument having a sharp point, with two rounded edges running from it—really a spoon excavator with the blade

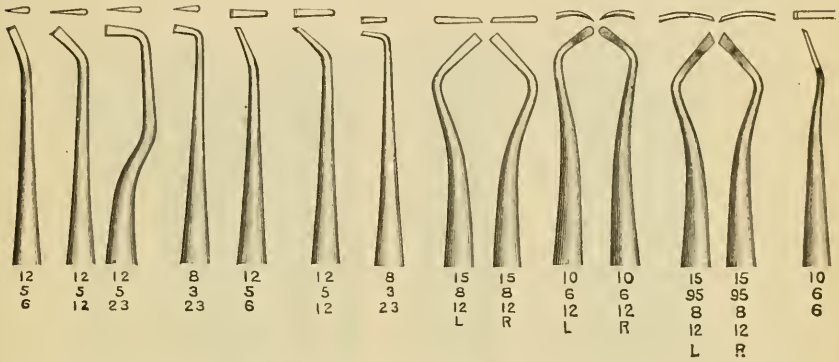


FIG. 61.—Black cutting instruments. Hatchet, hoe and spoon excavators, enamel hatchets, gingival margin trimmers and a bin-angle chisel. Formula names are shown.

running to a sharp point. It is especially designed for deepening the angles of pulp chambers at the canal entrances.

(b) **Chisel.**—An instrument designed after the ordinary carpenter's tool, and intended for cutting enamel. It is beveled on only one side, and the shank may be straight or bin-angled (Fig 62). *Enamel hatchet* is a variety of chisel in which the blade (bevelled on one side) is placed in hatchet form by contra-angling the shank (Fig. 61; 15–8–12). It is made in rights and lefts with the bevel on opposite sides for cutting enamel.

Gingival Margin Trimmer.—A variety of chisel especially designed for giving the proper bevel to gingival enamel mar-

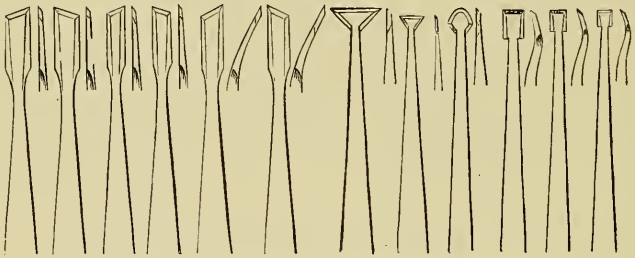


FIG. 62.—Chisels.

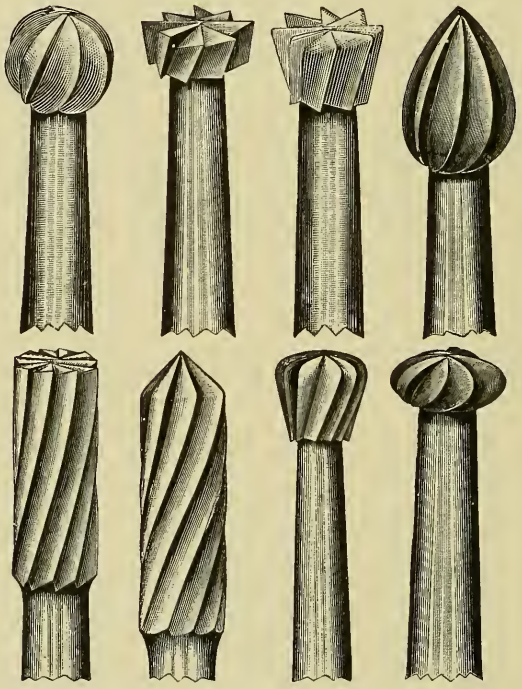


FIG. 63.—Engine burs (enlarged). The cone bur, being almost obsolete, is not shown.

gins; made in rights and lefts, two pairs of different size for

beveling mesial cavities (cavities on the mesial surface) and two pairs for distal cavities (Fig. 61; 15–95–S–12).

(c) **Bur.**—A form of drill for revolution in the handpiece of the dental engine, intended for the rapid cutting of tooth structure during the removal of decay and preparation of cavities. Burs may be divided into two groups, according to shape and depending on whether intended to cut round or plane surfaces (Fig. 63).

FIG. 64.—The round bur. Showing formation of the cutting blades.

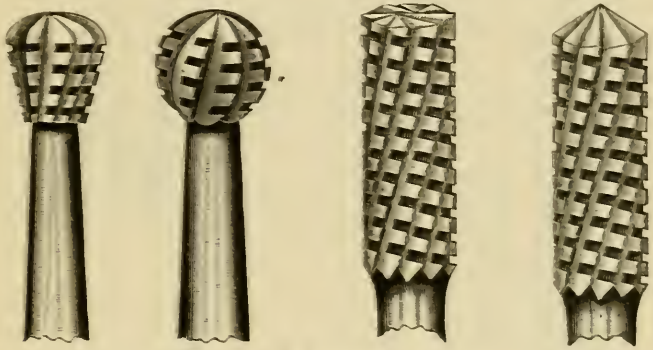


FIG. 65.—Enlarged dentate burs.

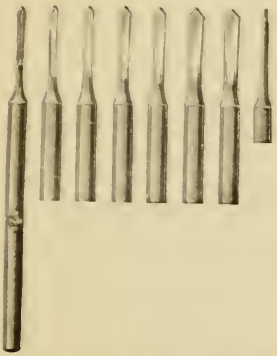


FIG. 66.—Spear-point drills.

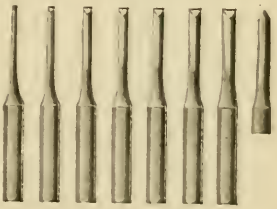


FIG. 67.—Square drills.

Group 1 for cutting concave surfaces, includes the *round* (Fig. 64), *oval*, *pear*, *bud* and *pointed fissure* burs.

Group 2 for cutting plane surfaces and angles, includes the *cone*, *inverted cone*, *wheel* and *square* or *flat-end fissure* burs.

Dentate Burs are burs with the cutting blade divided into teeth, very rapid cutters, intended especially for attacking enamel (Fig. 65).

Plug-finishing Burs are burs of a finer cut, of similar shape to those mentioned in Groups 1 and 2, intended for finishing and burnishing fillings.

(d) **Drill.**—An engine instrument used for boring or drilling holes in tooth structure (as in opening into a pulp chamber from the surface, where no cavity exists) or in bone (as during the treatment of an alveolar abscess). A drill is also valuable for following out fissures and for removal of old fillings. The *Spear-point* (Fig. 66), *Square* (Fig. 67) and *Twist* (Fig. 68) drills are familiar forms. A special form, known as a *Diamond* drill, is valuable for drilling cavities in artificial teeth. Drills may be readily made from old fissure and inverted cone burs by beveling them on opposite sides. A *bi-beveled dentate fissure bur* made from an old dentate bur is valuable for drilling through enamel and dentin.

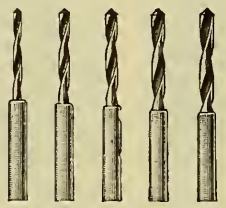


FIG. 68.—Twist drills.

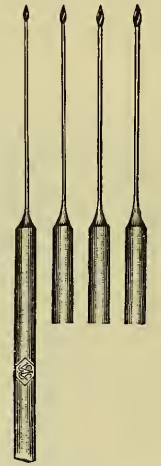


FIG. 69.—Gates-Glidden reamers.

(e) **Reamer.**—An engine instrument for enlarging root canals during treatment. Drills should never be used for this purpose on account of the danger of perforation. A *flexible* reamer, which will follow the route of the canal and enlarge it, is usually indicated. Well-known varieties are the *Beutelrock* and *Gates-Glidden* reamers (Fig. 69). The *Peeso* and *Ottolengui* root reamers (non-flexible) are used for great enlargement during the placing of dowels. The *Kerr tapered canal reamers* (spiral form) (Fig. 70) are valuable for enlarging the entrance to canals.

(f) **Lancet.**—Synonyms, **Scalpel, Bistoury.** An instrument of knife form, designed for cutting the soft tissues. Lancet is applied more frequently to that form of knife for use about the mouth, as in the

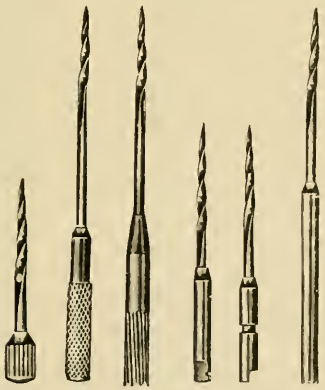


FIG. 70.—Kerr tapered canal reamers. B, C, and D are hand instruments. 2, 2 and 7 are for the engine.

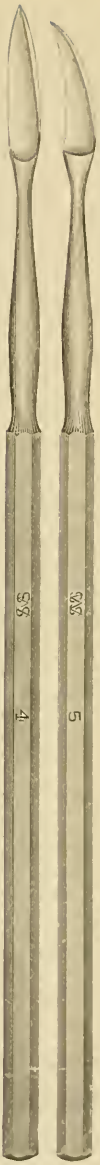


FIG. 71.—Bistouries.

lancing of abscesses and in all minor oral surgery operations (Fig. 71).

(g) **Scaler.**—An instrument for the removal of calculus. The blade is similar to the hoe and hatchet excavator. The instrument has various angles in the shank, and is used mostly with a pull cut (Fig. 72). Scalers are made in rights and lefts, in many different sizes and shapes, some for the removal of large deposits on the crowns of teeth, and others for minute particles at the neck and under the gum (Fig. 73).

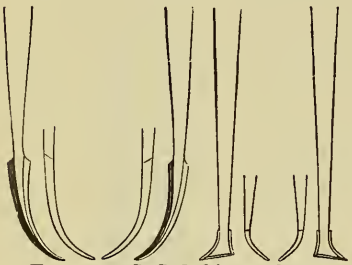


FIG. 72.—S. S. White scalers.

(h) **File.**—An instrument designed for filing down or removing surplus filling material. The *Black* (Fig. 74), *Searle* and "*Flexo*" files (Fig. 75) are prominent examples. *Rheine's*

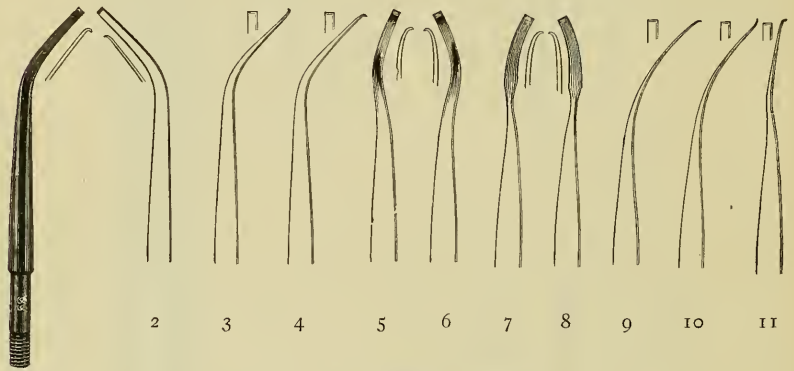


FIG. 73.—Thompkin's scalers.

and *D. D. Smith's Approximal Trimmers*, popular varieties, are also useful.

(i) **Saw.**—The saw is generally used in a special frame, and has teeth on one or both sides. It is useful for separating

teeth and for trimming surplus material from proximal fillings. The *Kaeber, Wilson, Clapp, Gordon-White* and *"thin-ribbon"*

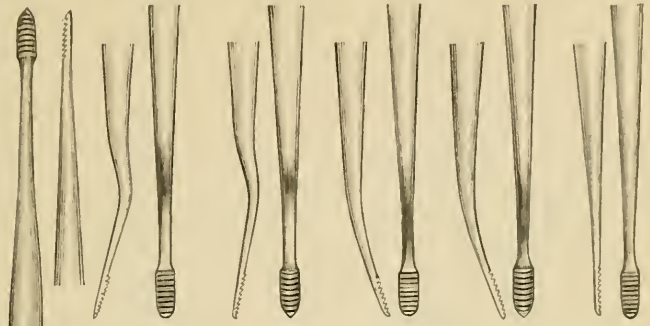


FIG. 74.—Black files.

saws are prominent varieties (Fig. 76).

(j) **Knife.**—Synonym, *Trimmer.* An instrument with a thin, knife-like blade, made in various shapes, designed for trimming or shaving off surplus filling material at the gingival, buccal and lingual margins of proximal fillings. *Black's* (Fig. 77), *Wedelstaedt's, Pichler's* (Fig. 78) and *Gordon-White's* are all useful examples.

(k), (l), (m), (n) **Wheel, Point, Disk, Strip.**—**Wheel.** A small grindstone, ranging from 1/2 inch to 1 inch in diameter, of various thicknesses and made of *corundum* or *carborundum*, of which the latter is harder, cuts more rapidly and lasts longer (Fig. 79). **Point, Disk.** Made of the same materials and of *vulcarbo*, the **Point** (Fig. 80) being of various shapes, as barrel, cone, bud, bell, etc., and ranging in several sizes. Also made of Arkansas, Scotch and Hindoostan stone when intended for finer grinding, these materials being of a much

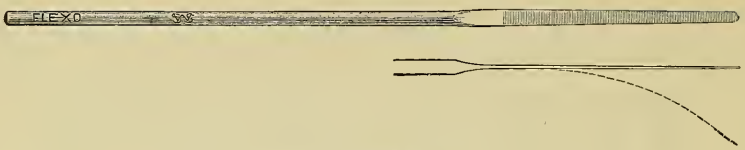


FIG. 75.—"Flexo" file.

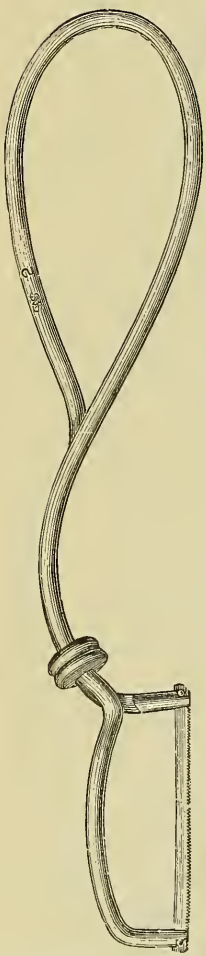


FIG. 76.—Kaeber saw-frame and saw.

smoother grain than carborundum. The *"Gem" Point* is excellent for finer grinding and for cavity margins. The *Diamond Point* and *Disk* are likewise valuable for cutting enamel, separating and finishing. The Diamond is largely utilized in this form for drilling cavities in artificial teeth. **Disks** (Fig. 83) are also made of paper and cloth, charged with emery, sand, garnet and cuttle-fish bone for polishing purposes (Fig. 82). The cuttle-fish disk is the finest grain of these, and is intended for very fine cutting and polishing. A variety of disk known as *Crocus* is very valuable for putting an extremely velvety finish to gold fillings. *Disks* for carrying polishing powders, such as pumice, corundum flour, chalk, oxide of tin, whiting and rouge are made of celluloid, felt, leather, moose hide, soft rubber, chamois, etc.; while *points* for the same purpose are made of wood, leather, felt, chamois and soft rubber (Fig. 81). Special *mandrels* are made for mounting all of the above (Fig. 84). Cloth and paper STRIPS of various widths and charged with the same materials as the disks, as well as with carborundum, flint and lava, are utilized for

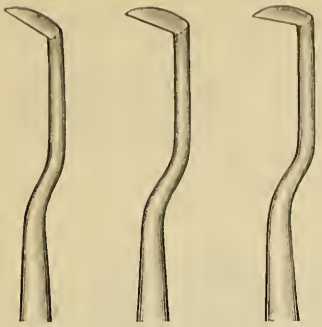


FIG. 77.—Black knives.

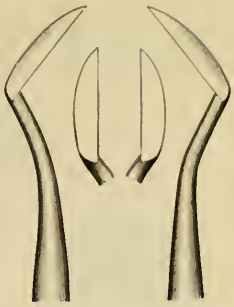


FIG. 78.—Pichler knives
Right and left.

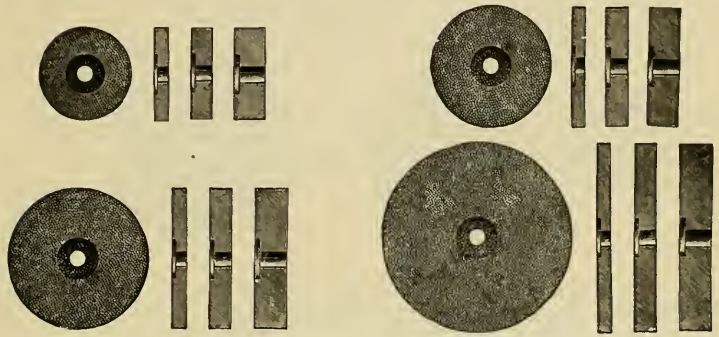


FIG. 79.—Carborundum wheels.

FIG. 80.—Carborundum points.

FIG. 81.—Soft rubber polishing points.

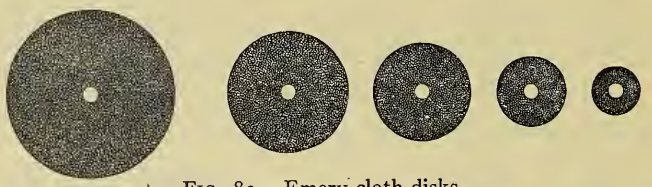


FIG. 82.—Emery cloth disks.

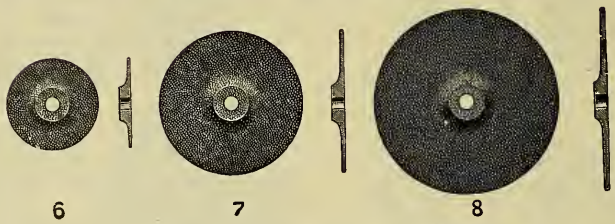


FIG. 83.—Carborundum disks.

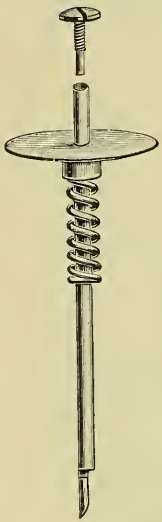


FIG. 84.—Disk mandrel.

finishing and polishing fillings. *Celluloid strips* are valuable for finishing silicate fillings and for use as matrices.

Sharpening Cutting Instruments.

The workman is known by his tools. A glance into the operating case of a student or a dentist is sufficient to enable a good judge to gauge the capabilities and character of work being done by its owner.

Cutting instruments should be kept sharpened if ideal results are desired. The possession of a good Arkansas stone (Fig. 85) is essential to the attainment of this object. The stone should

be slightly moistened with a drop or two of lubricating oil. Avoid too much oil. The passage of an excavator or chisel over the stone with a few long, firm strokes will be sufficient, if resorted to at regular intervals, to keep the instrument sharp. Care should be taken to follow the original bevel of the blade and not to establish false bevels during the sharpening process.

FIG. 85.—Arkansas stone in case.

The stone should rest on a firm surface, should be kept clean and free from grit and scratches. Some dentists prefer to hold the instrument to be sharpened in the left hand while manipulating the stone backward and forward with the right.

2. **Condensing Instruments.**—*Definition:* Instruments designed for packing, plugging or condensing, mixing and smoothing filling materials.

(a) Plugger (c) Spatula
(b) Burnisher (d) Mallet.

(a) **Plugger.**—An instrument designed for plugging,

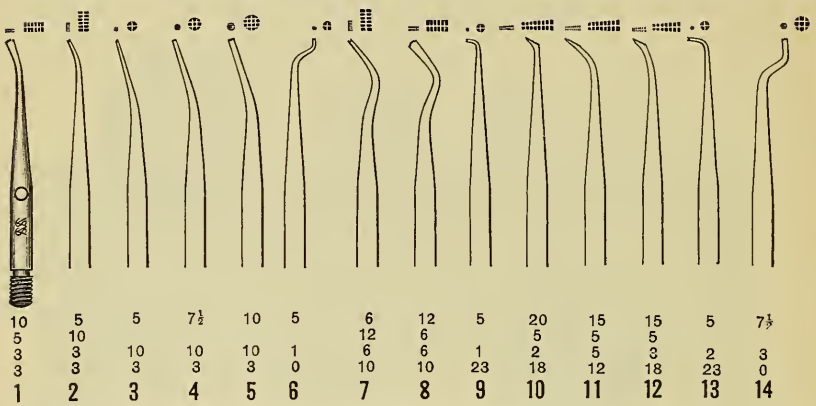


Fig. 86.—G. V. Black set of cone-socket plugger points. Formula names are given.

packing or condensing filling materials. (1) Gold and (2) Amalgam Pluggers. (1) *Gold Plugger* (Fig 86). For plugging

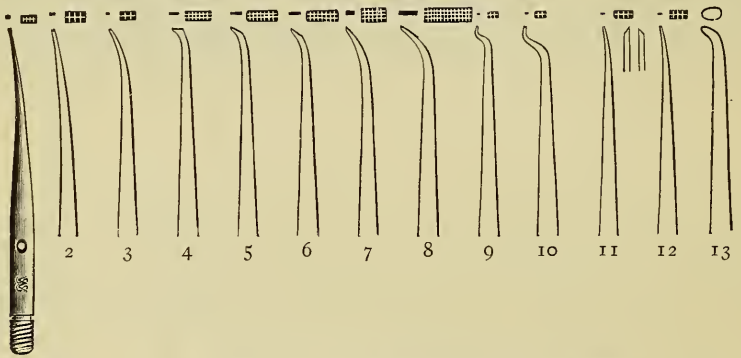


Fig. 87.—Varney set of gold pluggers—cone-socket.

or building gold, a plugger with a small face or *nib* should be used (0.5 mm. to 1 mm. in size), while for the final condensa-

tion of the filling a larger size (foot plugger) should be utilized. The gold plugger is made for hand pressure, hand-mallet or some form of mechanical mallet (Fig. 87). The working point or nib is serrated (Fig. 88) and in most instances presents a plane surface, though some are rounded or convex, while some are concave (Fig. 89). The outline form is either round, oval, square, oblong or parallelogram, triangular, or foot-shaped (Fig. 90). (2) *Amalgam Plugger.* For packing and condensing amalgam a larger size plugger is indicated, the selection depending on the size and shape of the cavity (Fig. 91). The amalgam plugger should be serrated to obtain the best results, though many with smooth faces (burnishers) are manufactured. Amalgam pluggers, as well as gold pluggers, are made in cone socket or long handle, with all forms of angle in the shank (Fig. 92).

(b) **Burnisher.**—An instrument designed for burnishing and smoothing the surface of a filling and for inserting cement, gutta-percha and amalgam into cavities (Figs. 93, 94 and 95). Burnishers are made of steel, agate, bloodstone, ivory, German silver and tantalum. For burnishing the surfaces of fillings, steel is the best material, while for working cements, instruments made

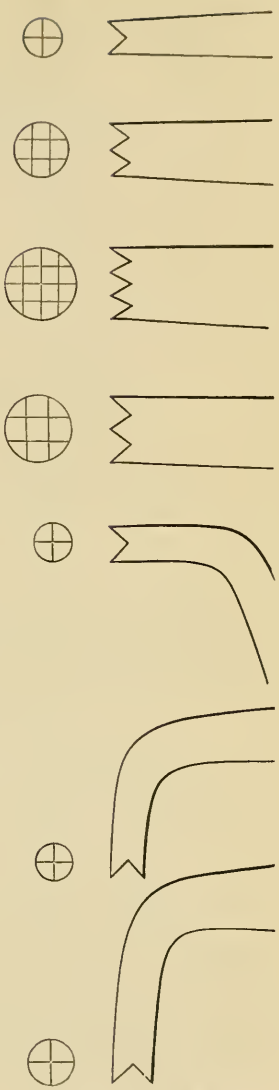


FIG. 88.—Diagrammatic illustration showing serrations in the nibs of the round instruments in the Black set of pluggers.

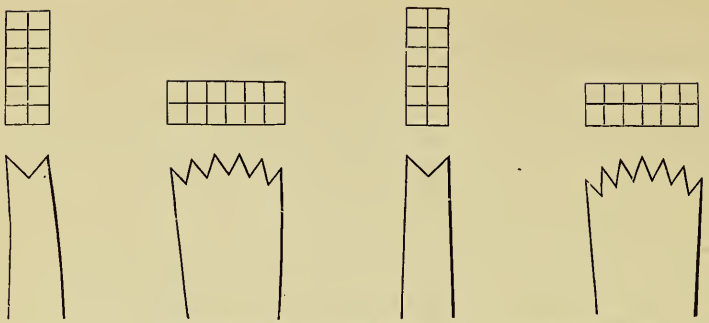
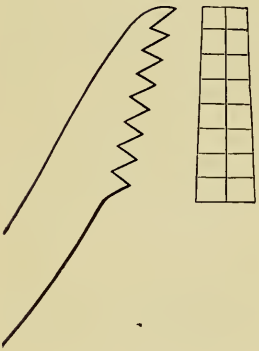
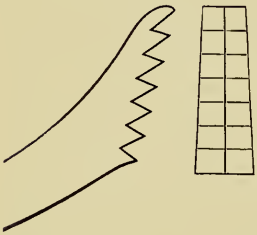


FIG. 89.—Serrated nibs, parallelogram form. Black pluggers.



of some of the other materials may be utilized. The silicate cements do not allow of contact with steel, so that the agate, tantalum, ivory and tortoise-shell instruments are used in their manipulation. Burnishers are primarily hand instruments, but they are also made to be used in the engine hand piece for burnishing the surface of fillings, when they are known as **engine burnishers.**



(c) **Spatula.**—An instrument with a flat, unsharpened blade, made in various sizes, for mixing cement and for introducing and smoothing the surface of cement fillings. A spatula is made of steel, German silver, bone, tantalum or other material (Fig. 96).

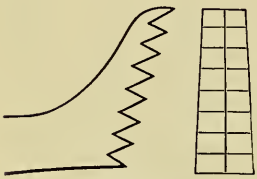


FIG. 90.—Foot pluggers. Black set.

(d) **Mallet.**—Hand and Mechanical. The **hand mallet** is made of wood, lead, steel and other materials, in various sizes and weights. It is utilized for malleting gold and amalgam fillings, driving wedges in separating teeth and

in delivering blows for other purposes, as in chiselling enamel. The **mechanical mallet,** designed for plugging gold, is of four

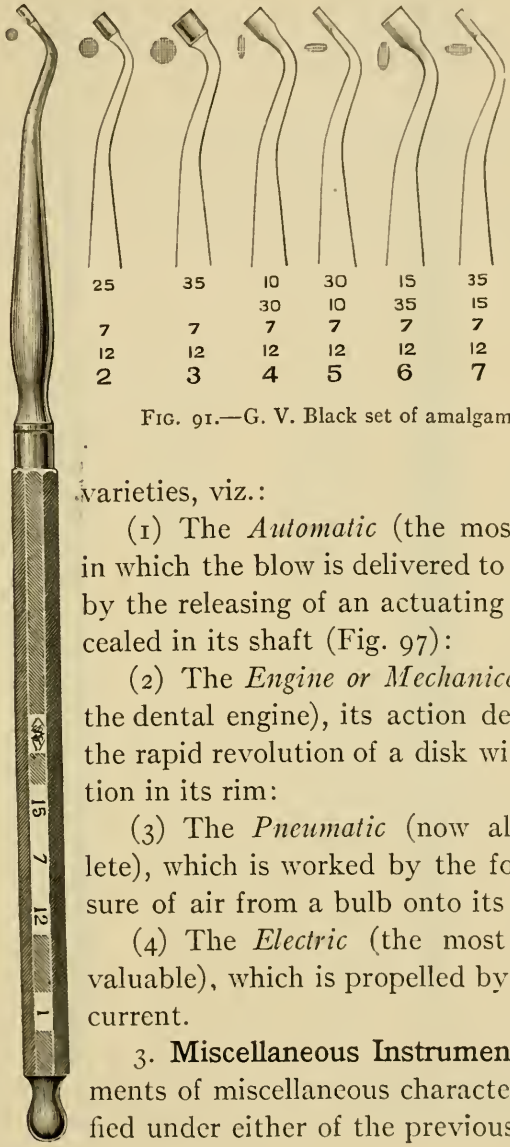


FIG. 91.—G. V. Black set of amalgam pluggers.

varieties, viz.:

(1) The *Automatic* (the most popular), in which the blow is delivered to the plugger by the releasing of an actuating spring concealed in its shaft (Fig. 97):

(2) The *Engine or Mechanical* (used on the dental engine), its action depending on the rapid revolution of a disk with a projection in its rim:

(3) The *Pneumatic* (now almost obsolete), which is worked by the forcible pressure of air from a bulb onto its piston; and

(4) The *Electric* (the most rapid and valuable), which is propelled by the electric current.

3. **Miscellaneous Instruments.**—Instruments of miscellaneous character not classified under either of the previous headings:

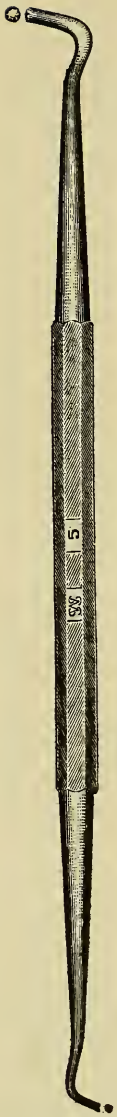


FIG. 92.—Loaded amalgam carrier and plugger.

FIG. 93.—Burnisher.

(a) Explorer
(b) Broach
(c) Separator
(d) Matrix
(e) Pliers
(f) Clamp
(g) Scissors
(h) Syringe
(i) Mandrel

(a) **Explorer.**—Cavity Explorer—Canal Explorer. A *cavity explorer* is a small, sharp-pointed instrument, made in various shapes for searching out cavities of decay (Fig. 98). A *canal explorer*, or *smooth broach*, is a small, delicate instrument, with a long taper and sharp point, made in various sizes for following the intricacies of canals.

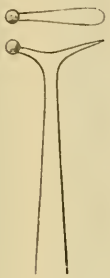


FIG. 94.—Burnisher.

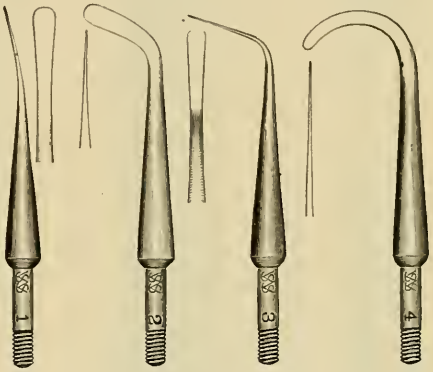


FIG. 95.—Thin burnishers.

(b) **Broach.**—An instrument designed for the exploration, measurement of the length and dimension, removal of the contents, enlargement and filling of root canals.

(1) Smooth broach
(2) Hooked broach
(3) Barbed broach
(4) Twist broach

(1) A *smooth broach*, in addition to the uses already given, is also utilized for placing dressings in and drying out canals.

FIG. 96.—German silver cement spatulas. The metal is not acted upon by the cement liquid.

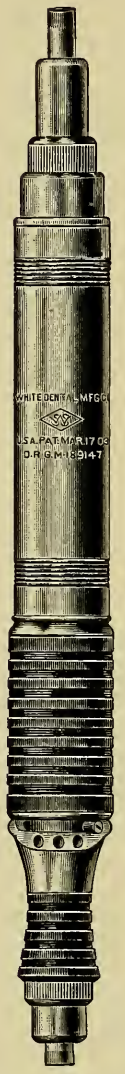


FIG. 97.—Automatic plugger.

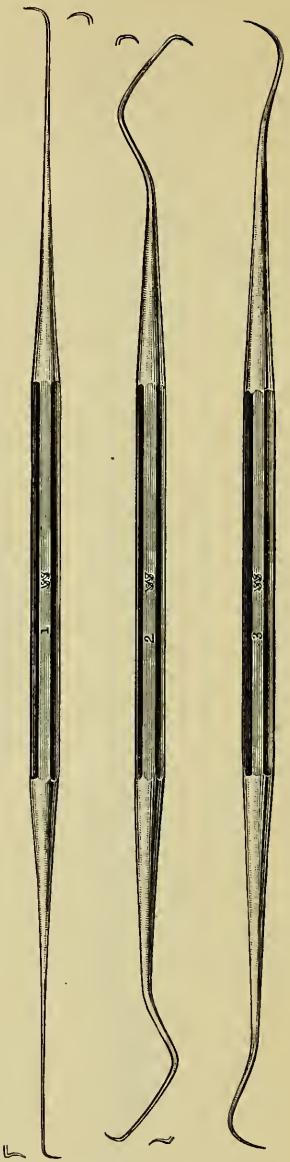


FIG. 98.—Double end cavity explorers. Rights and lefts. Numbers 2 and 3 are contra-angles.

One variety is *round*, another is *square* (also known as a Swiss or Jeweler's broach or reamer) and others are three or five sided. The smooth broach may be obtained annealed or un-annealed, the un-annealed variety being extremely brittle

FIG. 99.—Enlarged barbed broach.

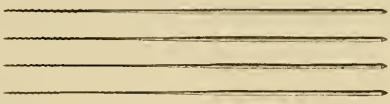


FIG. 100.—S. S. White canal cleaners. (Barbed broaches.)

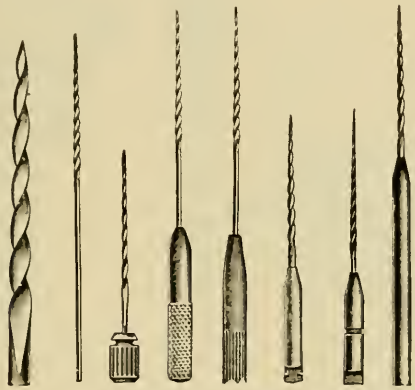


FIG. 101.—Kerr twist or spiral broaches. No. 1 is enlarged. B is a nub-broach. Nos. 6, 7, 8, are for the engine hand-piece.

FIG. 102.—Metal broach-holder.

and easily broken. For canal work the temper should usually be drawn, as already described. (2) *Hooked broach*—hooked extractor—a smooth broach with a hook on the end, either at a right or acute angle, used for removing pulps and for

measuring the length of canals. (3) *Barbed broach*—canal cleanser—a broach with small barbs or teeth, used for removing pulps and for *rasping* the sides of canals during cleansing and enlarging operations (Fig. 99). It is made in extra fine, fine, medium, or large sizes and may be obtained in packages of six assorted, or in the separate sizes. Prominent forms are the *Donaldson*, the *S. S. White* (Fig. 100) and the *Fellowship* broaches. (4) *Twist broach.* A tapered spiral broach, designed and operated on the principle of an auger,

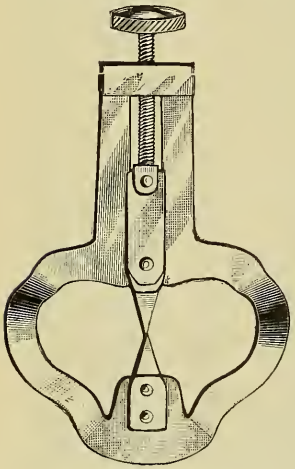


Fig. 103.—Ivory universal double-bow separator.

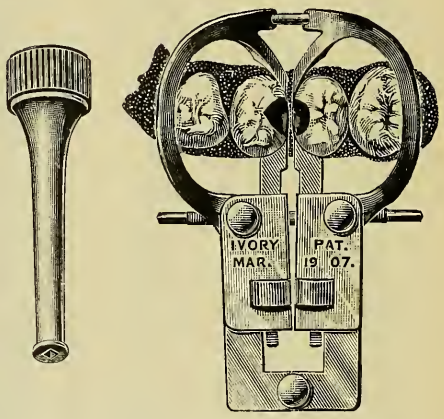


Fig. 104.—Ivory separator. New form.

for enlarging or reaming canals (Fig. 101). It is made in extra fine, fine, medium, coarse and extra coarse sizes, and is a much safer instrument than the engine reamer. It, as well as the other varieties of broach, is designed to be used either in a *broach handle* (broach holder) (Fig. 102) or as a long-handle instrument. There is also a variety of twist broach known as a **Nub broach** (see illustration, Fig. 101) intended for operations on the lower teeth. Of these the *Downie* and *Kerr* are the most prominent makes.

(c) **Separator.**—A steel instrument, designed for forcing apart (wedge separator) or drawing apart (traction separator) two approximating teeth, thus gaining space for making examination of, or operating in, inter-proximal spaces. The *wedge separator* acts on the principle of a wedge, by the forcing together of two steel points; the *traction separator* acts in the opposite manner by the drawing apart of two pairs of points; while some instruments combine both principles. The *Ivory* (Figs. 103 and 104), "*Perry*" (Fig. 105), "*Little Giant*" *and Elliot* (Fig. 106) separators are prominent examples.

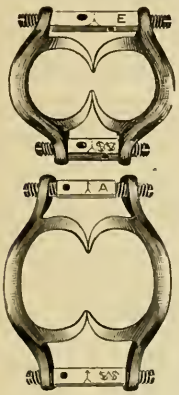


FIG. 105.—Perry separators.

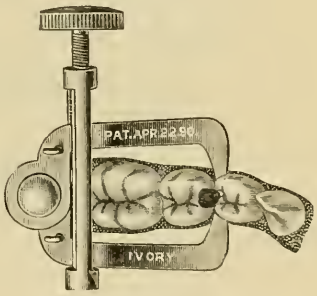


FIG. 106.—Elliot separator.

Separation of the teeth is also accomplished through the expansive properties of such materials as wood, cotton, linen tape and gutta-percha (slow or previous separation).

(d) **Matrix.**—A thin band or strip of steel, German silver or copper about 0.001 inch in thickness, used to restore the fourth or missing wall in filling proximo-occlusal cavities, thus converting them into simple cavities. The simplest form of matrix is a thin strip of metal held in position by means of a wooden wedge. The patent varieties of matrix are numerous, consisting of the *matrix band* and its *retainer*, and

range from those occupying one inter-proximal space to those partially or completely encircling one or two teeth. In some, provision is made for immediate separation of the teeth

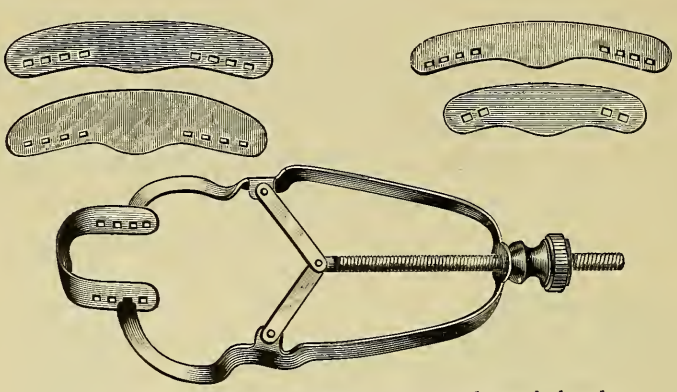


FIG. 107.—Ivory matrix retainer No. 1 and matrix bands.

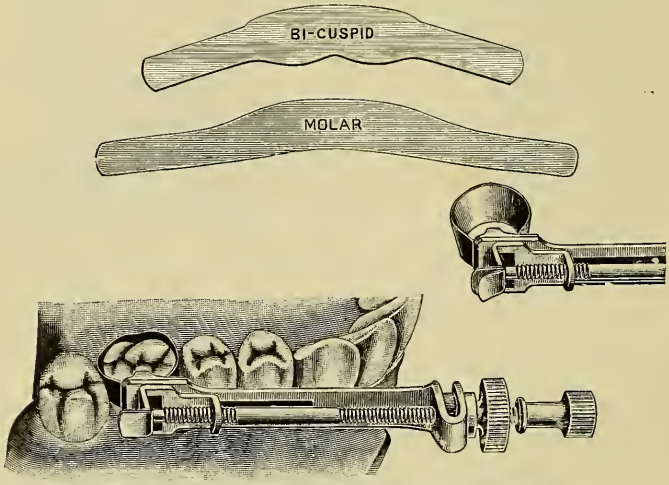


FIG. 108.—Ivory matrix retainer No. 8 with bands.

during their application. The *Ivory*, *Brophy*, *Woodward* and *Crenshaw* are prominent forms (Figs. 107 and 108).

(e) **Pliers.**—"A kind of pinchers by which any small object may be seized and bent"—Webster's Unabridged

Dictionary. *Dressing Pliers* are utilized for carrying cotton for purposes of swabbing, drying or medicating cavities and pulp chambers. Another variety of pliers, known as a *foil carrier*, is used for handling gold, the beaks of some of these being serrated, when they are known as *plugging pliers*. *Cone-socket pliers* are used for tightening cone-socket instruments in the handle.

(f) **Clamp.**—"Something that fastens or binds"—Webster's. A *rubber dam clamp* is a small steel appliance to clamp the neck of the tooth and hold the rubber dam in position (Figs. 109 and 110). An infinite variety of forms and sizes have been designed for every conceivable shape of tooth, although the bicuspid and molar clamps are most used. They are carried into position by means of *rubber dam clamp forceps* (Fig. 111). The "Ivory" and "S. S. White" line of clamps are the most prominent varieties. A form known as the *cervical clamp* is utilized in cases where it is necessary to force the dam well up beyond the margin of cervical cavities. Of these the *Ivory* (Fig. 112), *Dunn*, *Johnson*, (Fig. 113), *Keefe* and *How* (Fig. 114)

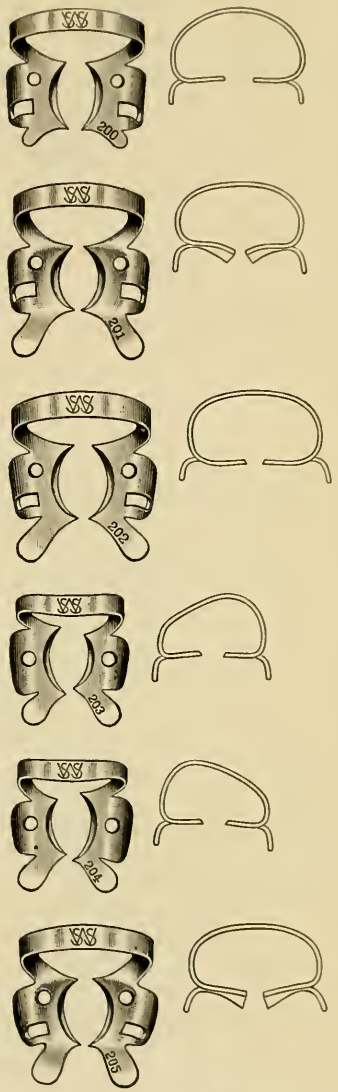


FIG. 109.—S. S. White rubber dam clamps for molars. The ivory clamps are practically of the same form.

may be mentioned. *Matrix Clamp* is another name for Matrix Retainer. A *Cotton Roll Clamp* is a clamp designed to hold napkins or cotton rolls in position in the mouth for excluding moisture.

Adjuncts and Accessories

(a) Ligature
(b) Rubber Dam
(c) Absorbent
(d) Mirror
(e) Scissors
(f) Syringe

(a) **Ligature.**—Waxed floss silk is the most popular material for ligating the rubber dam in position. Hemp thread

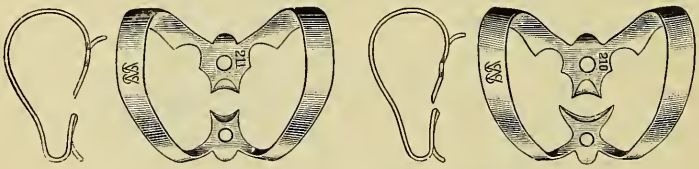


Fig. 110.—Rubber dam clamps for anterior teeth.

or gilling twine and small sea-grass fish line are also used for this purpose, as well as for regulating teeth, on account of their additional strength. Brass and copper wire are likewise valuable for this purpose in special cases.

(b) **Rubber Dam** (c) **Absorbent.**—In operating in the mouth, *dryness* is essential. For *short* operations, the teeth to be operated upon may be excluded from moisture by the use of small folded napkins, or cotton rolls (absorbents) of various sizes. For *long* operations small holes are punched in rubber cloth (rubber dam) and this is ligated in position, or held, by means of rubber dam clamps (Figs. 115 and

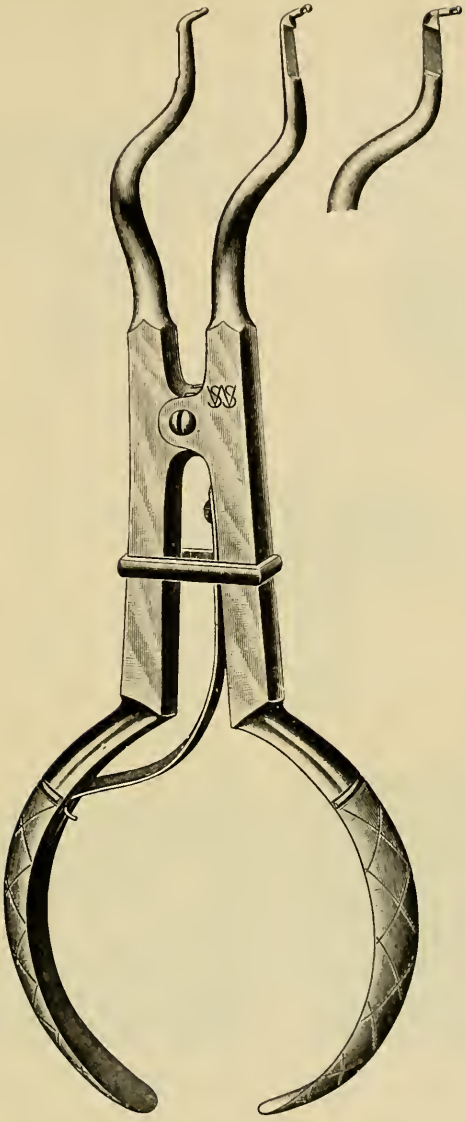


FIG. 111.—Rubber dam clamp forceps.

116). For drying the surfaces of teeth, cavities, pulp cham-

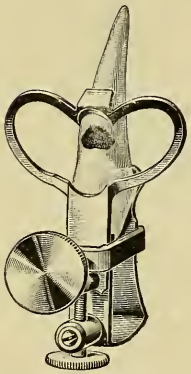


FIG. 112.—Ivory cervical clamp.

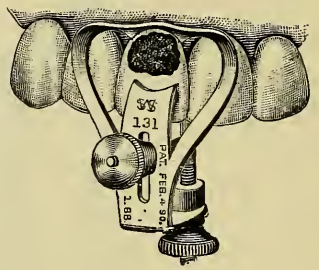


FIG. 113.—Johnson cervical clamp.

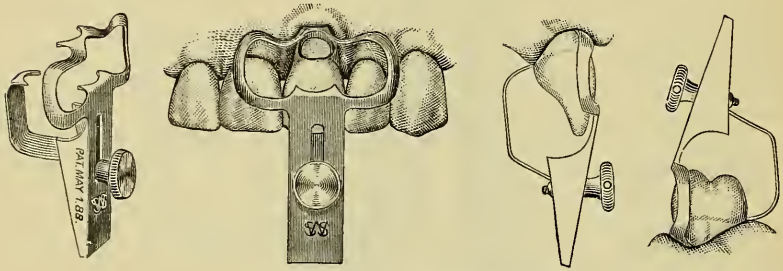


FIG. 114.—How cervical clamp.

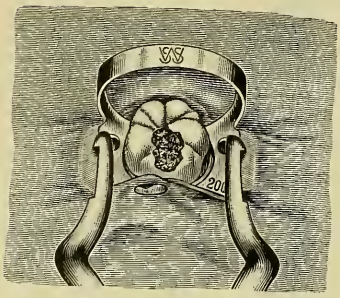


FIG. 115.—Adjusting the rubber dam.

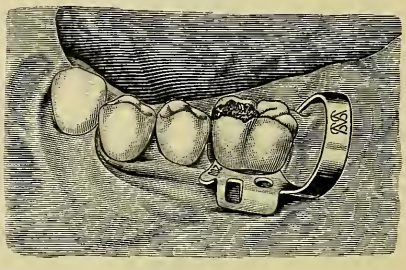


FIG. 116.—The rubber dam adjusted.

bers and canals, cotton, cottonoid, spunk and bibulous paper (absorbents) are the principal agents used.

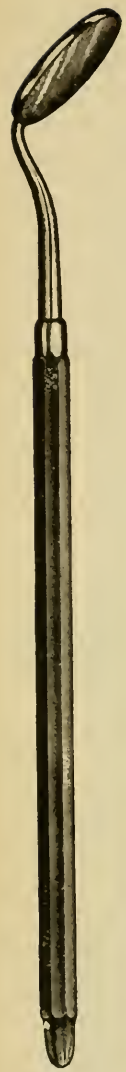


FIG. 117.—Mouth mirror with contra-angled shank.

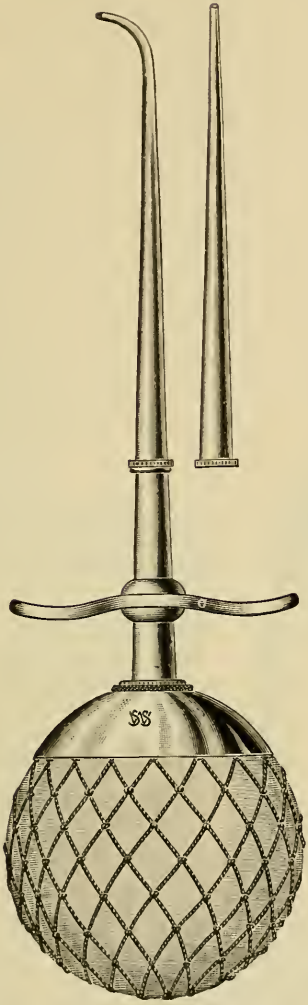


FIG. 118.—Water syringe with rubber bulb.

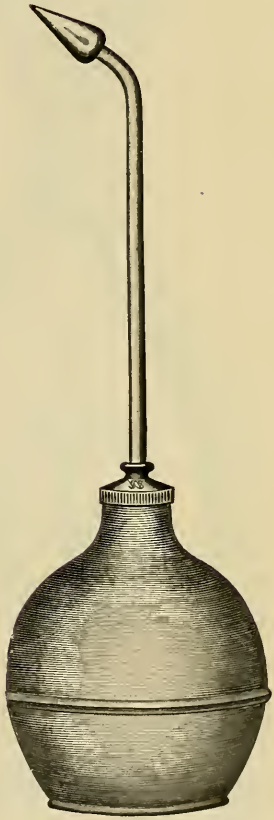


FIG. 119.—Chip blower.

(d) **Mirror.**—For reflecting the light into various parts of the mouth and for reflecting the images of cavities, fillings and other objects in inaccessible positions, the mouth mirror, either plane or magnifying is utilized (Fig. 117). For general work, the *plane* mirror (non-magnifying) is best, while for examining purposes the *concave* (magnifying) mirror may be used.

Various forms of scissors for cutting superfluous gum

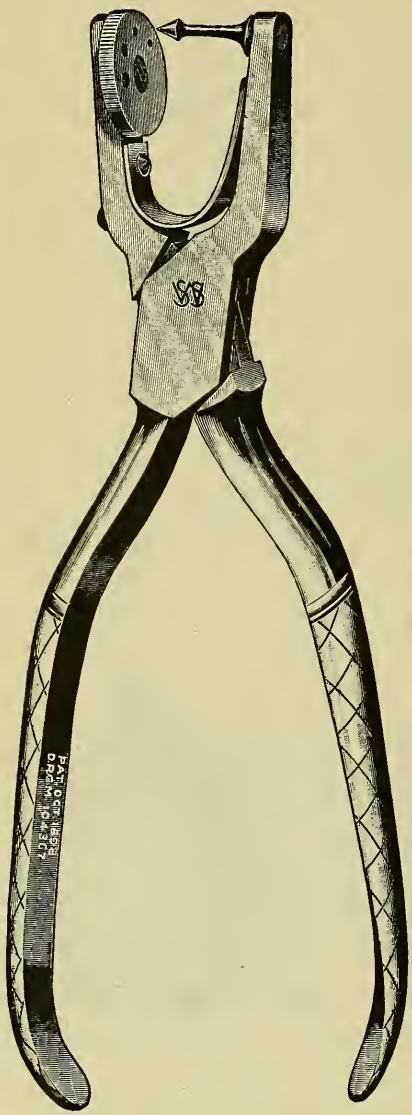


Fig. 120.—Ainsworth rubber dam punch.

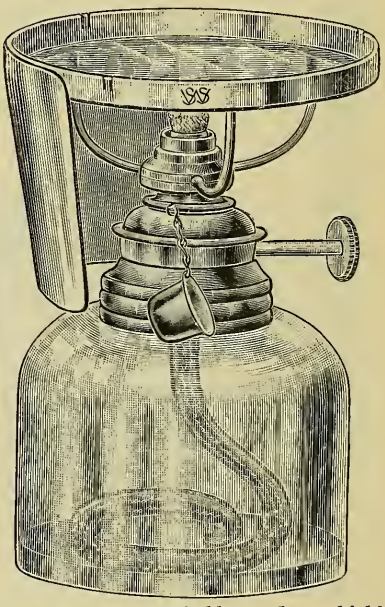


Fig. 121.—Alcohol lamp, flame shield and gold annealer.

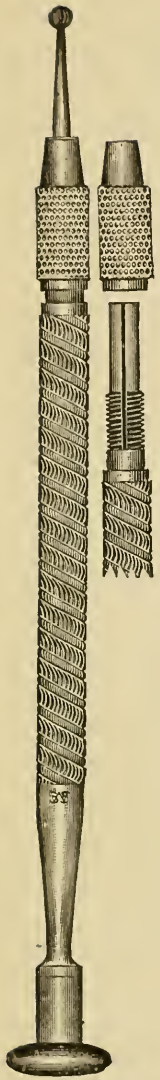


FIG. 122.—Revolving head engine bur holder for laboratory use.

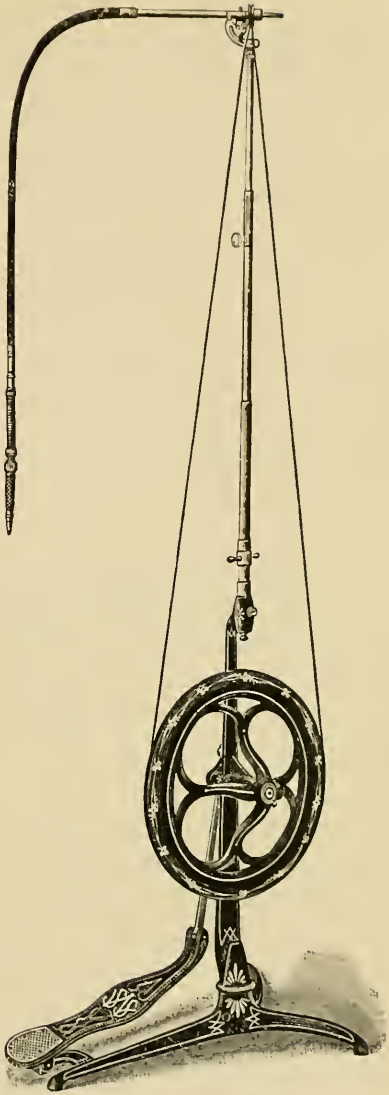


FIG. 123.—Dental engine.

tissue, cotton, gold and rubber; water syringes (Fig. 118): hot air syringes and chip blowers (Fig. 119) for drying and removing débris from cavities and canals; rubber dam punches (Fig. 120) for punching holes in the rubber cloth; as well as many other accessories and appliances, will gradually become familiar articles to the student, and will not be touched upon here (Figs. 121, 122 and 123).

INSTRUMENT MAKING

Object.—To gain a knowledge of the process of hardening, tempering and annealing steel; of the proper methods of shaping and sharpening tools; of the reason for placing the various angles in the shanks; as well as gaining a familiarity with the class, subclass, order and formula names of the instruments.

Instrument blanks (see Fig. 228) may be obtained from the various dental instrument manufacturers—either in long-handle or cone-socket forms. The blanks are *annealed*, but should be re-annealed by the student before beginning the technic exercises in instrument making. The amount of technic work to be done will be regulated by the time at the disposal of the class. Where time will not permit of the making of a set of cutting instruments in steel, at least 6 or 8 long-handled instruments should be constructed, the balance of the work being done on annealed brass wire, 13-gauge, cut to 6-inch lengths. The student should make a complete set of the hand cutting instruments as used in the operative clinic of the college.

Technic Work in Steel. Instruments required.—

1. Blowpipe, foot bellows and tubing, or Bunsen burner
2. Bench vise

3. Pliers (round-nose and flat-nose)
4. Carborundum stones and chuck for lathe
5. Arkansas stone
6. Anvil
7. Hammer
8. Metal file
9. Instrument gauge
10. Felt cones and brush wheels for lathe
11. Emery paper and polishing powders.

Directions for Making Steel Excavators and Chisels

1. *Annealing.*—Select the blank of proper size and with the blowpipe or Bunsen burner heat the point and shank to *full cherry red* and allow to cool slowly. This anneals it and makes it soft and pliable.

2. Place the instrument to be duplicated, or a picture of it, together with a memorandum of its formula, before you.

3. With the millimeter gauge see if that portion to be made into the blade will need any change in form or dimensions; if so, procure the needed change with hammer and anvil or the file.

4. If necessary, file the shank down to the proper measurement and taper.

5. *Angling.*—Bend the shank by means of the pliers till the proper angles, as mon-angle, bin-angle, triple-angle, contra-angle, etc., are procured, as indicated by its formula, verifying them with the instrument gauge and by comparing with the model to be duplicated.

6. *Beveling.*—File the cutting edge of the blade to the proper bevel, verifying all dimensions with the millimeter gauge.

7. *Preliminary Polish.*—Remove all file marks with fine emery paper, then take to the lathe and give a high polish, first using pumice on a felt cone or wheel and later whiting and water.

8. *Hardening.*—Cover with soap, heat to a *full cherry red* color and plunge immediately in *cold* water. Be careful not to overheat the blank. Better underheat it, for if overheated the carbon is burned out and the instrument will not take a fine edge.

9. *Testing.*—Test with a file for proper hardness. If the file attacks the metal it is too soft. If this is the case, reheat as before and again plunge.

10. *Secondary Polish.*—Polish again according to the directions already given.

11. *Tempering.*—Place the shank of the instrument in the flame and heat to a *faint yellow* or *straw color*, plunging immediately in *cold* water or other media as indicated.

12. *Tertiary Polish.*—Polish again to remove the oxides formed on the surface, so that the colors may again be seen to appear in case of subsequent tempering.

13. *Spring Temper for Shank.*—Cover with soap and place the blade of the instrument in contact with a hammer or some other large piece of metal, so that it will conduct away the heat and prevent drawing the temper already given the blade. Place that portion of the shank back of where the temper is required in the flame, heat and watch closely for the *blue color*, on the appearance of which, plunge immediately as before.

14. *Sharpening and Final Polish.*—Again polish, and sharpen the blade for use.

Technic Work in Brass.—If the instruments are made in brass, practically the same procedures are followed, except that no hardening or tempering is required and the polishing is done only on completion of the work. The brass should be first annealed, when it is ready for the various manipulations (Fig. 124).

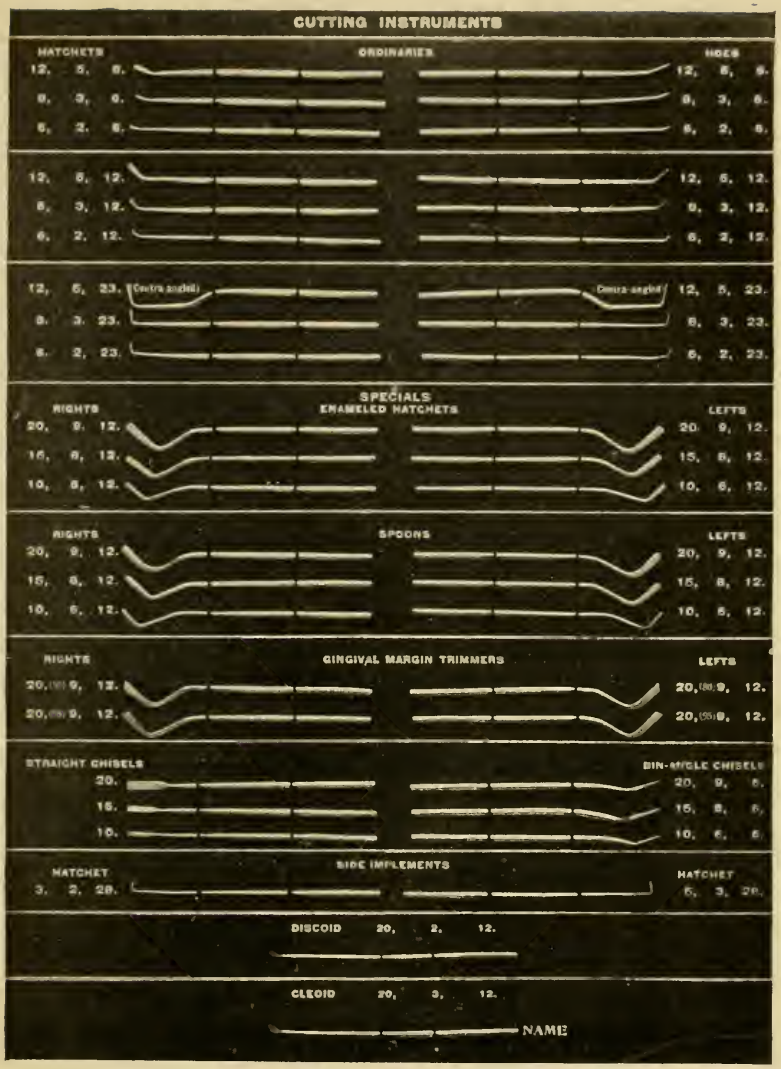


FIG. 124.—Set of instruments made from brass wire as used at Northwestern University Dental School. Courtesy of Dr. Fred. W Gethro.

CHAPTER III

PREPARATION OF CAVITIES

Causes of Decay.—Cavities occur in teeth as a result of decay beginning on their surface. Decay is the result of the **fermentation** of food debris. Fermentation is a decomposition of carbohydrates (starches, sugars, etc.). **Food debris** accumulates because of neglect in the application of the ordinary rules of cleanliness to the care of the teeth. Fermentation of food debris is due to the constant presence of **germs** in the mouth. The action of certain of these germs on the fermentable material produces **lactic acid.** Lactic acid dissolves out the **lime salts,** of which the major part of the tooth is composed. Other germs, constantly present, liquefy the **organic material,** which constitutes the remainder of the tooth. The result is a **cavity of decay.**

Definition.—By "preparation of cavities" is meant those procedures incident to the removal of decay and the shaping of the cavity, so that when filled, the tooth will be restored, as far as possible, to its original form and strength, and be immune from future decay in the same location.

Nomenclature.—A system of words, sounds or signs by which individuals of the same race, profession, or calling, are enabled to understand each other. The profession of dentistry has a nomenclature of its own. A study of the nomenclature of cavity preparation is essential to an understanding of the contents of the following chapter.

Angle.—The union of two surfaces along a definite line (*line angle*) or of three surfaces at a point (*point angle*).

Cavo-surface Angle.—The angle formed by the junction of the walls of the cavity with the surface of the tooth.

Axial Line Angle.—A line angle running parallel with the long axis of the tooth.

Pulpal Line Angle.—One running horizontally to the long axis of the tooth.

Wall.—One of the internal boundaries of a cavity.

Margin.—The junction of the walls of a cavity with the surface of a tooth.

Marginal Outline.—The shape of the cavity along its margins.

Dento-enamel Junction.—The line representing the junction of the enamel and dentin.

The nomenclature of cavity preparation followed and now considered official is that adopted by the **Institute of Dental Pedagogics,** from the report of a committee of which Dr. Thomas E. Weeks was Chairman, as follows:

CAVITY NOMENCLATURE

All that is to be said in describing cavity preparation can be expressed by the use of the following nouns and adjectives:

Cavity	Surface	Labial	Mesial	Gingival
Wall	Angle	Buccal	Distal	Axial
Margin	Thirds	Lingual	Incisal	Pulpal
Plane	Embrasure	Proximal	Occlusal	Subpulpal

Cavity Names

Cavities in the teeth take the names of the surfaces in which they occur.

- Cavity
  - Simple
    - Labial
    - Buccal
    - Lingual
    - Mesial
    - Distal
    - Occlusal
  - Complex
    - Mesio-incisal
    - Disto-incisal
    - Mesio-labial
    - Disto-labial
    - Mesio-lingual
    - Disto-lingual
    - Mesio-occlusal
    - Disto-occlusal
    - Linguo-occlusal
    - Bucco-occlusal
    - Mesio-distal-occlusal
    - (Other combinations by the same rule)

Wall Names

That wall of a cavity in an axial surface of a tooth that covers the pulp is called the *axial* wall. If the cavity is extended to include the pulp chamber this wall takes the name of the wall of the pulp chamber. The bottom or floor of occlusal cavities is called the *pulpal* wall. If extended to include the pulp chamber it becomes the *subpulpal* wall.

- Wall
  - Labial
  - Buccal
  - Incisal
  - Occlusal
  - Lingual
  - Mesial
  - Distal
  - Gingival
  - Axial
  - Pulpal
  - Subpulpal

Rule.—Cavity walls take the names of the surfaces of the tooth which they approach.

Angles (Simple Cavities)

Angles	Line (Axial)	Mesio-buccal	Occlusal cavities
		Mesio-lingual	
		Disto-buccal	
		Disto-lingual	
		Bucco-axial	Axial surface cavities
		Linguo-axial	
		Mesio-axial	
		Disto-axial	
	Line (Pulpal)	Bucco-pulpal	Occlusal cavities
		Linguo-pulpal	
		Mesio-pulpal	
		Disto-pulpal	
		Bucco-gingival	
		Linguo-gingival	
		Mesio-gingival	
		Disto-gingival	Axial surface cavities
		Axio-gingival	
		(and combinations with occlusal wall)	
	Point	Mesio-bucco-pulpal	Mesio-lingual-pulpal
		Disto-bucco-pulpal	Disto-linguo-pulpal

Point Angles (the union of three-line angles) take their names from the surfaces forming them. In occlusal cavities there are four.

In complex cavities on axial surfaces there is another horizontal line angle, *i.e.*, in axial cavities combined with occlusal, the one formed by union of the axial and the pulpal wall—**axio-pulpal.**

Division into Thirds

Cavities may be divided into thirds, for convenience in description, as teeth are divided.

Names of Margins

Margins	Mesial
	Distal
	Buccal
	Labial
	Lingual
	Incisal
	Occlusal
	Gingival

Nomenclature of Simple Cavities

	Occlusal Cavities	Labial, Buccal or Lingual Cavities
Walls	Mesial	Mesial
	Distal	Distal
	Buccal	Gingival
	Lingual	Occlusal or incisal
	Pulpal	Axial
Line angles (longitudinal)	Mesio-buccal	
	Mesio-lingual	
	Disto-buccal	Mesio-axial
	Disto-lingual	Disto-axial
Line angles (transverse)	Mesio-pulpal	Mesio-occlusal
	Disto-pulpal	Disto-occlusal
	Linguo-pulpal	Mesio-gingival
	Bucco-pulpal	Disto-gingival
		Occluso-axial
		Gingivo-axial
Cavo-surface angles	Mesio-occlusal	
	Disto-occlusal	
	Bucco-occlusal	Based on the same rule as for occlusal cavities
	Linguo-occlusal	
Point angles	Mesio-bucco-pulpal	Mesio-axio-gingival
	Disto-bucco-pulpal	Disto-axio-gingival
	Mesio-linguo-pulpal	Mesio-axio-occlusal
	Disto-linguo-pulpal	Disto-axio-occlusal
Margins	Mesial	Mesial
	Distal	Distal
	Buccal	Gingival
	Lingual	Occlusal or incisal

Simple cavities on proximal surfaces have the same number of walls, angles, and margins as those on other axial surfaces, and are named similarly.

With this basis all cavities, however complex, may be easily named and described.

CAVITY CLASSIFICATION, NOMENCLATURE, AND PREPARATION[1]

		Classification
Cavities.	Pit and fissure (no extension for prevention).	Cavities in the lingual surfaces of upper incisors.
		Cavities in occlusal surfaces of bicuspids and molars.
		Cavities in the occlusal two-thirds of the buccal and lingual surfaces of molars.
	Smooth surface (extension for prevention).	Cavities in the gingival third of the labial, buccal, and lingual surfaces.
		Cavities in proximal surfaces of incisors and cuspids which do not involve the mesial or distal incisal angle.
		Cavities in proximal surfaces of incisors and cuspids which do involve the mesial or distal incisal angle.
		Cavities in the proximal surfaces of bicuspids and molars.

Note.—Cavities occurring in consequence of arrested development are not included.

STEPS IN CAVITY PREPARATION

1. Establish the outline form.
2. Remove the decay.
3. Give the cavity proper form { (a) Convenience form. (b) Resistance form. (c) Retention form.
4. Bevel and polish the enamel margins.
5. Perform the toilet of the cavity.

[1] The above tables on cavity nomenclature were published in the American Textbook of Operative Dentistry, to the publishers of which acknowledgment is here extended.

1. **ESTABLISH THE OUTLINE FORM.**—Carry the marginal outline to the location which it will occupy on the completion of the cavity. This procedure, and *not the removal of the decay*, should be the first thought to enter the student's mind, for reasons which will be understood better as he progresses.

Rule 1.—*Extend the margins until solid tooth structure, free from decay, is reached.*

Rule 2.—*Leave no overhanging enamel margins unsupported by dentin.* The enamel of the tooth is extremely brittle, owing to its histological structure, and depends for its strength on the support which it receives from the underlying dentin.

Rule 3.—*In fissure cavities, extend the margins to include the entire fissure.* Pits and fissures are extremely liable to decay, and if this rule is not followed decay is liable to occur in that part of the fissure not included in the cavity, with a consequent undermining of the filling.

Rule 4.—*Extend the margins of cavities approaching closely to deep developmental grooves, to include the grooves* for reasons of strength, as well as for the reason given in Rule 3.

Rule 5.—*Unite two cavities approaching closely to each other,* to prevent the leaving of a weak ridge of tooth structure between them.

Rule 6.—*Extend the gingival margins of cavities occurring in the gingival third of labial, buccal and lingual surfaces under the free margin of the gum,* where they will be less liable to decay.

Rule 7.—*In proximal cavities extend the labial, buccal and lingual walls well out into the embrasures, into areas where they will be less likely to decay; the incisal or occlusal margins beyond the contact point; and the gingival margins under the free margin of the gum.* The extension of these margins, as laid down in this rule, follows the law known as "extension for prevention," which requires a brief explanation at this time.

Extension for Prevention

Proximal surfaces of the teeth are much more subject to decay than other portions, because **food** and **germs** accumulate more readily here, and are less easily removed. This being the case, if the margins of cavities are left in these **vulnerable areas,** they will be much harder to keep clean, and hence decay is likely to **recur** readily. Recognizing this fact, it is the accepted practice to **extend the margins** of cavities, when they occur in these areas, by cutting away enough of the tooth substance to carry them out to locations where the food is not so liable to deposit, and where they may be more readily cleansed. The food does not accumulate under the gum margin so much as it does a short distance occlusally to this point, hence the reason for **extension of the gingival margins.** Food accumulates very readily and frequently remains just **gingivally to the contact points** of two approximating teeth, and in order to obviate the necessity of leaving the incisal or occlusal margins within this vulnerable area, these margins are carried beyond this point down toward the **incisal,** or **occlusal surface,** where they can be more readily cleansed. **Buccal and lingual margins,** for the same reasons, are extended out **into the embrasures** for a certain distance, depending on the convexity of the tooth surface and the character of approximation.

There are many conditions, physical and otherwise, which **modify the operation** of extension for prevention in the mouth. In his technic course, the student will learn how to prepare **typical cavities** according to the extension for prevention theory, which was promulgated by G. V. Black, although he did not originate the term by which it is known. When he begins to operate in the mouth and advance further into the study of the causes of decay and its prevention, these condi-

tions will be more fully understood. At first, his tendency will be to *extend his margins too far, at the sacrifice of too much good tooth structure, and he should learn to guard against this evil.*

Drawings

Draw the typical outline form of the following cavities.

1. Fissure cavity on the occlusal surface of $\underline{4}$ or $\underline{5}$ running full length of the occlusal groove (Fig. 125).

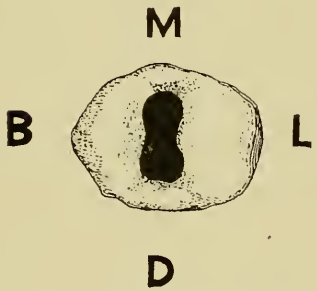


FIG. 125.—Outline form. Occlusal cavity on the upper first bicuspid.

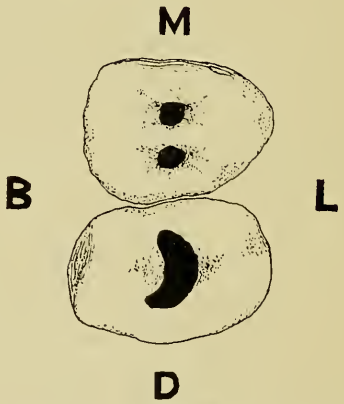


FIG. 126.—Outline form. Occlusal cavities on the lower first and second bicuspids.

2. Pit and fissure cavity on the occlusal surface of $\overline{4}$ and $\overline{5}$, occupying the mesial and distal pit in $\overline{4}$ and running full length of the groove in $\overline{5}$ (Figs. 126 and 127). In $\overline{5}$ there are two typical forms depending on the shape of the occlusal groove.

3. Cavity in central and distal fossæ of $\underline{6}$, $\underline{7}$ and $\underline{8}$ (Fig. 128). If the oblique ridge is left very weak, unite the cavities. If $\underline{8}$ has three cusps, the typical form will appear as in Fig. 129.

4. Cavity on the occlusal surface of $\overline{6}$ (Fig. 130).

5. Cavity on the occlusal surface of $\overline{7}$ (Fig. 130). On $\overline{8}$ the outline form will appear like that for $\overline{6}$, or $\overline{7}$, depending on the form of the tooth.

6. Mesial cavity on $\overline{1}$ (Fig. 131). The outline form for proximal cavities in the six anterior teeth, upper or lower, is about the same.

Technic for Establishing the Outline Form.

(1) *On Enlarged Plaster Teeth.*—(a) With a pencil draw the outline form. (b) With vulcanite chisels and scrapers remove enough of the plaster to establish a definite cavity.

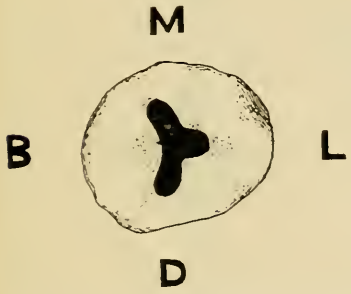


FIG. 127.—Outline form. Occlusal cavity in a lower second bicuspid with three cusps.

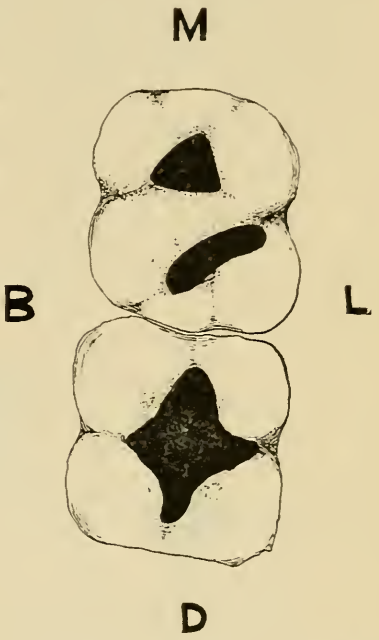


FIG. 128.—Outline form. Occlusal cavities in upper molars. In the second molar the two cavities have so undermined the oblique ridge that it has been necessary to unite them.

(2) *On the Technic Block.*—(a) With a pencil draw the outline form. (b) With chisels and excavators remove enough of the tooth substance to establish a definite cavity.

(3) *On Extracted Teeth.*—(a) With a pencil draw the outline form. (b) With the chisel cut away the overhanging

and unsupported enamel. (c) If necessary to extend further, first remove the underlying dentin with excavators (hoes, hatchets and spoons) and then chisel the enamel the desired distance.

2. **REMOVE THE DECAY.**—Complete removal of decay is essential. If the minutest portion be left unsterilized, decay will continue, producing irritation of the pulp via the dentinal fibrillæ and finally result in the undermining of the filling.

Technic for Removing Decay.

1. *On Extracted Teeth.*—(a) For removal of soft decay use the spoons and discoids. (b) For hard decay use hatchets and hoes.

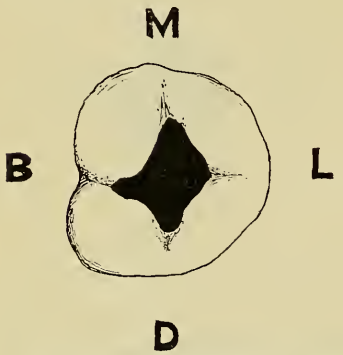


FIG. 129.—Outline form. Occlusal cavity in an upper third molar with three cusps.

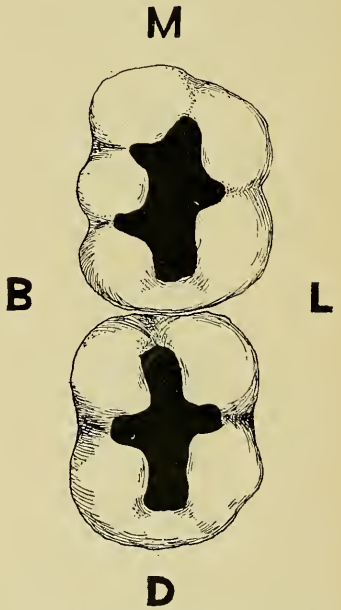


FIG. 130.—Outline form. Occlusal cavities in the lower first and second molars.

3. **GIVE THE CAVITY FORM.**—(a) **Convenience Form.** The shaping of the cavity in such a manner that it may be most conveniently seen and approached with instruments. If the cavity be of difficult access, owing to its location, the slight extension of a margin is frequently admissible for this purpose. The extension of the labial margins of proximal

cavities for convenience is not admissible, as this would result in too great a display of filling material. In every instance where it becomes necessary to extend margins for convenience form, the extension is made at the expense of the *lingual* margin, the filling being packed in that case largely from the lingual side. *The display of extensive gold operations in the front teeth is an offence against the esthetic sensibilities of all refined individuals, and a sure sign of a depraved taste on the part of both patient and operator.*

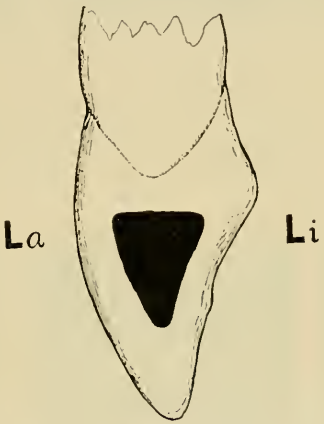


FIG. 131.—Outline form. Mesial cavity an the upper central incisor.

For convenience in starting gold, the **point angles** to be described under "retention form" are frequently deepened, or made more acute, this procedure, then, being really a convenience form (see Fig. 162).

(b) **Resistance Form.**—The so shaping of the walls of the cavity that they may be best enabled to withstand the **stress** brought to bear on the filling during the act of mastication. In mechanics, the general form of a cavity which is to receive an inlay is the box or **simple mortise.** This general idea is applied in preparing cavities in teeth. In this form,

all of the walls of the **mortise** are on plain or straight lines, joining each other at definite line and point angles.

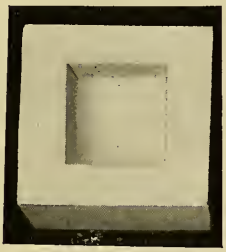


FIG. 132.

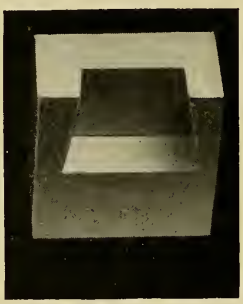


FIG. 133.

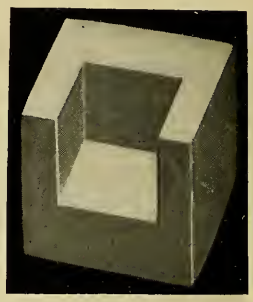


FIG. 134.

FIG. 132.—Simple mortise on one surface.

FIG. 133.—Simple dovetail mortise on one surface. The plaster block has been sawed in half to show the inside of the cavity, which is dovetailed on two opposite surfaces.

FIG. 134.—Simple mortise form involving two surfaces.

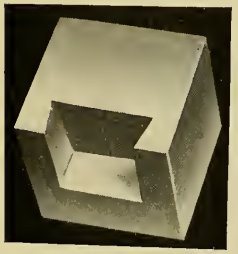


FIG. 135.

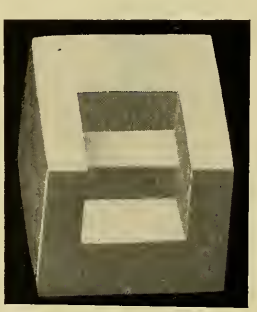


FIG. 136.

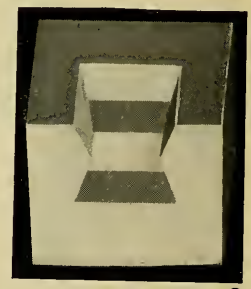


FIG. 137.

FIG. 135.—Method of dovetailing the simple mortise involving two surfaces, thus making it retentive in form.

FIG. 136.—Auxiliary mortise (step form).

FIG. 137.—Compound dovetail mortise.

Technical Exercises

On six cubes of plaster of Paris 2 inches square, prepare the six forms of mortise. Study the line and point angles in these imaginary cavities.

Rules for obtaining resistance form.

Rule 1.—In the shaping of all simple cavities, use the **simple mortise form,** or some modification of it. Examples

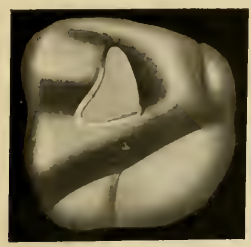


FIG. 138.

FIG. 139.

FIG. 138.—Cavity in the central fossa of a right upper first molar tooth.
FIG. 139.—Cavity involving the occlusal groove on an upper bicuspid.

illustrating the application of the simple mortise to cavity formation are seen in Figs. 138, 139, 140, 141, 142 and 143.

Rule 2.—In proximo-occlusal cavities on bicuspids and

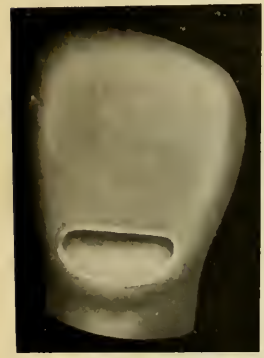


FIG. 140.

FIG. 141.

FIG. 142.

FIG. 140.—Cavity in the gingival third of the labial surface of a right upper central incisor.
FIG. 141.—Another form of preparation for cavities located on the gingival third.
FIG. 142.—Cavity involving the lingual pit of a left upper lateral incisor.

molars, where the strength of buccal and lingual walls will permit and there is no decay on the occlusal surface, use the **simple mortise form involving two surfaces** (see Fig. 144).

Rule 3.—In proximo-occlusal cavities in other cases than the above, use the **double, compound or auxiliary mortise form** (step form) (Fig. 145 and 146).

FIG. 143.

FIG. 144.

FIG. 143.—"Gingival third" cavity on the buccal surface of a bicuspid.

FIG. 144.—Application of the simple dovetail mortise form to a disto-occlusal cavity in an upper molar, where the occlusal surface presents good union of enamel plates and is free from decay.

Rule 4.—In proximo-incisal cavities, where the loss of the mesio- or disto-incisal angle is not extensive and where the

FIG. 145.

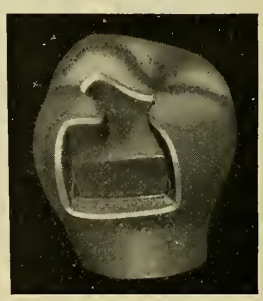


FIG. 146.

FIG. 145.—Application of the compound mortise form to a mesio-occlusal cavity on an upper bicuspid.

FIG. 146.—Step form in a mesio-occlusal cavity on an upper molar.

stress of mastication is not great, use the **simple mortise form.** (Figs. 149, 150, 151.)

Rule 5.—In proximo-incisal cavities, when the involvement

of the incisal edge is extensive, use the **double, compound or auxiliary mortise form,** either in the shape of an incisal step or a lingual step form (see Figs. 152, 153, 154, 155 and 159).

Technic for Obtaining Resistance Form.

Use hatchet and hoe excavators and straight-edged chisels. All of these cut plane surfaces, joining at definite angles, and give the box or mortise form.

1. **Pit and Fissure and "Gingival Third" Cavities.**—With the excavators and chisels **flatten** the pulpal or axial wall of the cavity, and true up the lateral walls until they are **plane**

FIG. 147.

FIG. 148.

FIG. 147.—Cavity running full length of the lingual groove on an upper molar.
FIG. 148.—Cavity involving the central and distal fossæ and lingual groove on an upper molar.

surfaces, parallel with each other and joining with the pulpal or axial wall (the seat) at **definite angles** (see Figs. 138, 139, 140, 141, 142, 143, 147 and 148).

2. **Cavities in the Proximal Surfaces of the Incisors and Cuspids not Involving the Angle.**—(a) With the hatchets, hoes and chisels, flatten the gingival and axial walls, making a definite **line angle** at their junction. (b) Bring the axial, gingival, labial and lingual walls together at two definite **point angles** (labio-gingivo-axial and lingo-gingivo-axial point angles). (c) Join the labial and lingual walls together at a definite **point angle** at the incisal portion of the cavity, the re-

sultant form being triangular in shape, with three definite point angles (Figs. 149, 150 and 151).

3. **Cavities in Proximal Surfaces of Incisors and Cuspids Involving the Angle.**—(a) If the simple mortise form is adopted the procedure is practically the same as that described in the preceding paragraph, consisting in **flattening** the gingival and axial walls and joining them at a definite **line angle,** the gingivo-axial line angle. The resistance form is afforded by

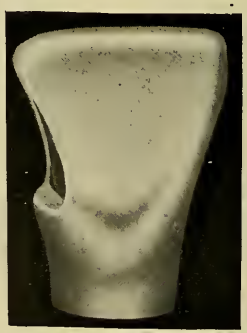


FIG. 149. FIG. 150. FIG. 151.

FIG. 149.—Mesial cavity on an upper central incisor showing the flat gingival wall. Labial view.

FIG. 150.—Lingual view of the same cavity shown in Fig. 149.

FIG. 151.—Cavity shown in Figs. 149 and 150 seen from a different aspect. The triangular form with three point angles is noticeable.

the flat gingival wall. (b) *Incisal step form.* After obtaining the form as described in "(a)," with a chisel (except in extracted teeth) cut a **step** about one-half or two-thirds the distance across the cutting edge of the tooth, exposing the imaginary dentin and removing as little of the labial plate of the imaginary enamel as the tooth will allow. Then, with a hoe, remove the imaginary dentin between the labial and lingual enamel plates, cutting mesio-distally, until a

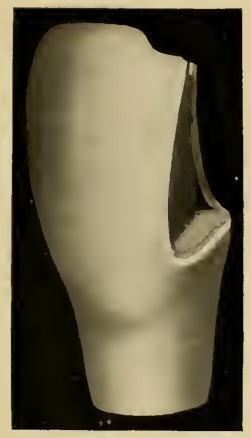


FIG. 152.

FIG. 153.

FIG. 152.—Mesio-incisal cavity on an upper central incisor. Labial view. An effort has been made to preserve as much of the labial enamel plate as conditions will permit.

FIG. 153.—Lingual view of the cavity shown in Fig. 152. The flat gingival wall is well shown; also the cutting of the incisal step more at the expense of the lingual wall in order to preserve the labial enamel plate.

FIG. 154.

FIG. 155.

FIG. 154.—Lingual step form in an upper lateral incisor. The gingival wall, instead of being made flat, has been cut to follow the curvature of the gingival line somewhat, in order to provide a better seat and anchorage for the filling.

FIG. 155.—Labial view of the mesio-incisal cavity with lingual dovetail, shown in Fig. 154.

groove is formed. Now, with the chisel, cut away more of the lingual enamel plate, and then with the hoe deepen the groove, continuing thus, always cutting at the expense of the lingual side, till the **step form** is complete and will allow a sufficient bulk of filling material for strength (Figs. 152 and 153). (c) *Lingual step form.* Where the tooth is too thin, labio-lingually, to warrant the incisal step, prepare an **auxiliary mortise form** on the lingual surface of the tooth with the chisels, hoes and hatchets, as illustrated in Figs. 154 and 155. The floor of this step is made flat and the

Fig. 156.

Fig. 157.

Fig. 156.—Simple cavity on the proximal surface of a bicuspid. A form which is seldom, if ever, admissible.

Fig. 157.—Proximo-occlusal cavity an an upper bicuspid. Step form.

lateral walls plane surfaces, joining the floor at definite line angles.

4. **Cavities in Proximal Surfaces of Bicuspids and Molars.**—Extend the cavity through the marginal ridge on to the occlusal surface. When the occlusal grooves and fossæ are perfect and the strength of the buccal and lingual walls permits, the **simple mortise form** involving the proximal and occlusal surfaces may be adopted (Rule 2) (see Figs. 135 and 144). In the majority of cases, however, the cavity is made to include the occlusal groove or fossa, utilizing the **com-**

pound mortise or step form. (a) *Simple mortise form.* In natural teeth, remove the dentin underlying the marginal ridge with the hoe or hatchet excavator, and then chisel away the enamel, carrying the cavity well over on to the occlusal surface. In other cases, chisel away the marginal ridge. With hoes and hatchets flatten and **render plane** the gingival, axial, buccal and lingual walls, joining them along **definite line angles,** and giving the cavity the typical box form (Fig. 144). (b) *Compound mortise form.* (Step

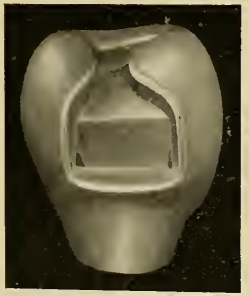


FIG. 158.

FIG. 159.

FIG. 158.—Proximo-occlusal cavity on a bicuspid. Compound mortise or step form.
FIG. 159.—Another view of the cavity shown in Figs. 152, 153.

form.) Extend the cavity in the form of a **step** by means of the chisels, hatchets and hoes, the full length of the occlusal groove (bicuspids) or to include the entire central or distal fossa (molars). Flatten the gingival wall (the seat) as before, make the **buccal and lingual walls parallel** with each other and joining the gingival wall at right angles. Make a definite **line angle** at the junction of the gingival and axial walls (gingivo-axial) and definite **point angles** (bucco-gingivo-axial and lingo-gingivo-axial) at the buccal and lingual

termination of this line. Flatten the top of the **step,** the pulpal wall, and cut that portion of the cavity to the **box form** with its line and point angles (Figs. 145, 146, 157 and 158).

Seat.—In simple cavities the bottom or floor of the cavity, either the axial or pulpal wall.

Step.—The auxiliary portion of the compound mortise form, consisting of the axial and pulpal walls in complex cavities.

FIG. 160.

FIG. 161.

FIG. 160.—Step form in a disto-incisal cavity on an upper cuspid.
Fig. 161.—Labial view of a mesio-incisal cavity on an upper cuspid showing flat gingival wall.

(c) **Retention Form.**—The so shaping of the cavity that the filling may be enabled to resist **tipping or lifting stress.** (1) *In pit and fissure and gingival third cavities*, where the *depth* of the cavity is greater than its *diameter*, no extra retention form is needed, the filling being retained by its contact with the lateral walls of the cavity. The accomplishment of this condition, though, is not often admissible, owing to the proximity of the pulp. In the majority of cases, then,

retention is provided for by transforming the simple mortise form into the dovetail mortise form (Fig. 133). In doing this, one, or at most two, opposite walls of the cavity are **slightly dovetailed.** (2) *In proximal cavities on incisors and cuspids not involving the angle,* retention is provided for by **making more acute** the labio-gingivo-axial, lingo-gingivo-axial and the incisal **point angles** (Figs. 149 and 151). (3) *In proximal cavities on incisors and cuspids involving the angle,* the gingival and incisal point angles are deepened as in "(2)," for the **simpler cases.** In the **incisal step** form, the entire step, which has been given a flat floor, is **dovetailed** on its labial and lingual walls, and slightly deepened at its extremity (Figs. 153 and 159). In the **lingual step** form the step is **dovetailed** throughout, and its two point angles rendered more acute (Fig. 154). (4) *In proximo-occlusal cavities on bicuspids and molars* the gingival **point angles** are rendered more acute in both the simple mortise form and the compound mortise form (Figs. 144, 157 and 158). The **simple mortise form** is now transformed into the **dovetail mortise** form by cutting at the expense of the buccal and lingual walls, rendering the cavity wider, bucco-lingually, at the junction of the buccal and lingual walls with the axial wall (Fig. 144). In the **compound mortise form,** after accentuating the gingival point angles, dovetail the lateral walls of the **auxiliary portion** (the step), and slightly deepen the two point angles in that portion (Figs. 145, 146 and 158).

Technic for Retention Form.

Use the chisel, hatchet and hoe. In deepening the gingival point angles, do so more at the expense of the **axial, labial, buccal** and **lingual** walls, than of the gingival wall. Place the blade of the instrument in the point angle, and after slightly deepening it at the expense of the gingival wall, cut

along the line angle uniting the labial, buccal or lingual wall (as the case may be) with the axial wall, for a distance of about one-fourth the length of the wall, thus forming a slight groove, which gradually disappears at its termination (Fig. 162). For making the incisal retention form in proximal cavities in incisors and cuspids, use the *acute angle hatchet*, placing its blade in the point angle and cutting at the expense of the **labial** and **lingual** walls, as well as deepening the angle toward the **incisal.** (See Illustration, Fig. 151.)

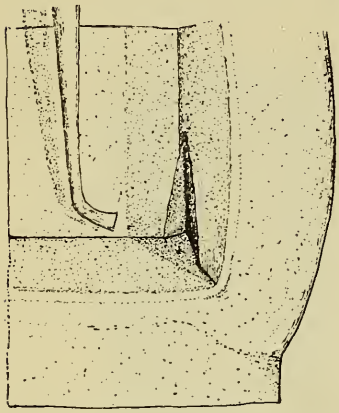


Fig. 162.—Accentuating the gingival point angle for convenience and retention form.

4. **BEVEL AND POLISH ENAMEL MARGINS.**—What has been said about resistance and retention forms applies entirely to the dentin, these forms being provided for at the expense of that material. The enamel is an extremely **brittle** substance, owing to its chemical composition (being composed largely of inorganic salts) and its histological structure. **Microscopically,** it consists of numerous layers of hexagonal shaped rods, united together with cementing substance. Each individual rod is composed of prisms placed end to end, each of these also united (much more firmly than the rods) with cement substance. **Mechanically,** the material resembles a brick wall, the prisms representing the individual bricks and the rods representing a single layer of them, the layers being superimposed one upon the other. The difference, though, between the enamel and the brick wall is that in the wall the various layers run parallel to the surface on which they are placed, while in the enamel they run perpendicular to the dentin, radiating around in various direc-

tions, depending on the surface from which they are viewed, *one end of the rod lying on the dentin, the other being at the surface.*

If the underlying dentin be first undermined by decay or through the action of cutting instruments, these rods may be easily **chipped away in layers** in the direction of their length, by means of chisels. Owing to the fact that they run in various directions, depending on location, it is necessary that a

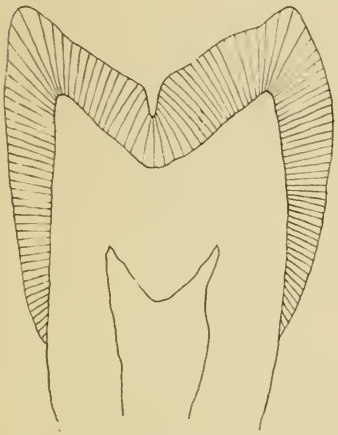


FIG. 163.—Diagram showing the direction of the enamel rods on a bicuspid. Mesial view.

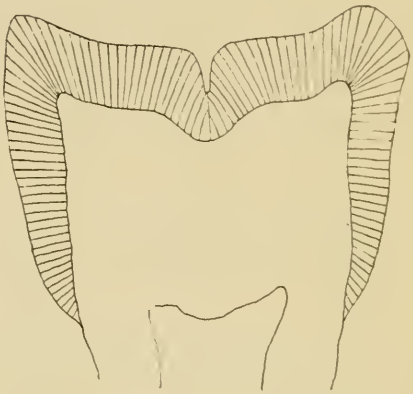


FIG. 164.—Radiation of the enamel rods on a molar. Mesial view. (Diagrammatic.)

brief study of them be here made, in order that we may intelligently and expeditiously **chisel** them away.

Rule.—On plane surfaces the enamel rods are placed **perpendicular** to the dentin; on concave surfaces they radiate toward each other, while on convex surfaces they radiate away from each other.

By referring to the illustrations (Figs. 163 and 164), it will be seen (1) that their outer ends approach each other at pits and fissures in **bicuspids and molars**: (2) that they radiate more and more to the perpendicular, as the points

of the cusps are reached; (3) then, as we go over to the axial surfaces, they begin to run more and more horizontally to the long axis of the tooth; and (4), as the cervical line is approached, their outer ends begin to radiate toward the cervical, following the general law already mentioned, *viz.*, that they run perpendicular to the surface of the dentin.

Practically the same conditions exist in the **centrals, laterals and cuspids,** the same general laws being applicable

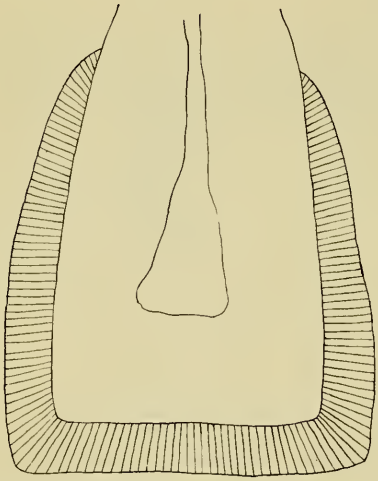


FIG. 165.—Radiation of enamel rods on an incisor. Labial view. (Diagrammatic.)

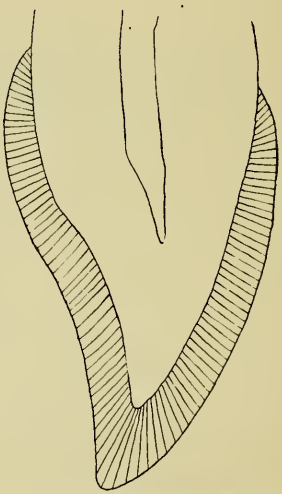


FIG. 166.—Proximal view of a central incisor showing radiation of enamel rods. (Diagrammatic.)

(Figs. 165 and 166). (1) On incisal surfaces the rods are perpendicular to the long axis of the tooth; (2) at the angles the rods on the incisal and axial surfaces approach each other; (3) while on axial surfaces they lie more or less horizontal to the long axis of the tooth; (4) radiating gingivally as the cervix is approached.

In the manipulations incident to the fourth step of cavity preparation, the established law is to **bevel** the enamel mar-

gins outward, following the direction of the rods in the location in which we are working. The dentin is the natural support of the enamel. A study of the accompanying illustrations will demonstrate why bevel of these margins is necessary in order that no rods be left unsupported, the amount of bevel depending on the direction of the rods. In **pit and fissure** cavities very little bevel is necessary, the amount being increased with the increase in size of the cavity, and the approach of its margins toward the points of the cusps. In **proximal** cavities a marked bevel is indicated at the gingival margin (see illustration), while the amount on the incisal margins will depend on their proximity to the angle and the convexity of the surface, the rods deviating more at the angles and on distal convex surfaces.

In centigrades the amount of bevel for cavity margins will usually range between 2 and 7 degrees, depending on location and the filling material to be used. *The tendency of beginners will be to bevel too much.*

Technic for Beveling and Polishing Enamel Margins.

Chisels of razor-like sharpness are the instruments indicated in the majority of cases. The bevel should always be a definite one, and on *straight* lines, not curved. If the chisel is of proper sharpness, the margins may be sufficiently smoothed and polished. *When two margins join each other at an angle, the angle should be slightly rounded, being careful to leave the definite line angle in the underlying dentin.* For gingival margins, Black's gingival trimmers are constructed so as to give the proper bevel. These may also be used on buccal, labial and lingual margins, or else the Black enamel hatchets.

Technic.—Bevel with chisels the margins of the cavities in the plaster cubes illustrating the various mortise forms; also those prepared in the plaster and extracted teeth, as well as on the technic block.

5. **PERFORM THE TOILET OF THE CAVITY.**—Remove all debris, smooth the walls, cleanse and dry thoroughly with cotton, inspect for and remove any remaining decay, after which the cavity is ready for filling.

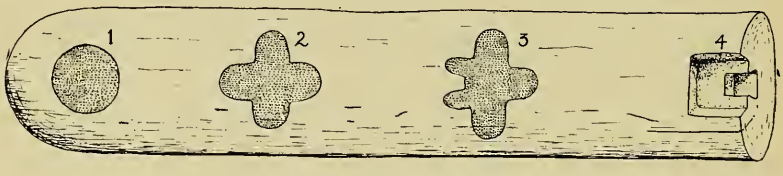


FIG. 167.—Bone handle.

Technical Exercises

1. **Preparing Cavities in the Bone Handle.**—This handle may be obtained from the Wenker Dental Mfg. Co., or the S. S. White Dental Mfg. Co. (Figs. 167, 168).

FIG. 168.—Bone handle.

Prepare with hatchets, hoes and chisels the six cavities indicated in the illustration; numbers 1, 2 and 3 on the broad

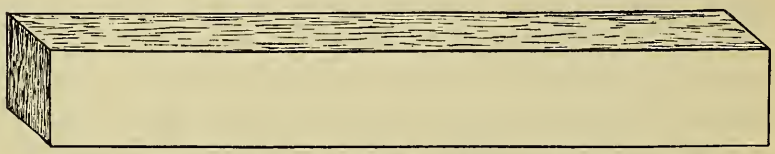


FIG. 169.—Celluloid handle or block for cavity preparation exercises.

side of the handle and number 5 on the narrow side, representing the ordinary form of pit and fissure and gingival third

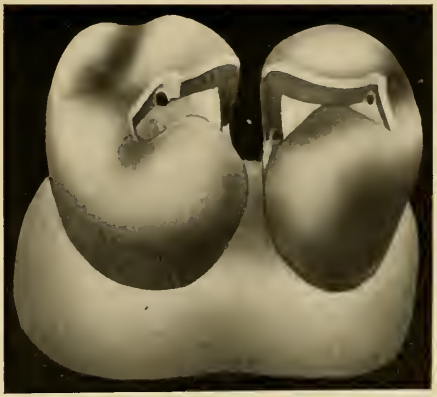


FIG. 170.—Plaster technic model for cavity preparation.

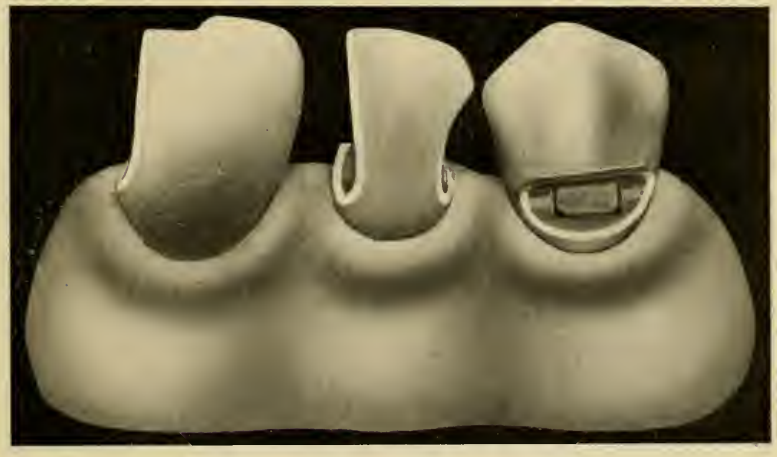


FIG. 171.—Plaster technic model for cavity preparation.

cavities; number 6, a proximal cavity on an incisor; number 4 on the flat end, being similar in shape to the step form in molars.

2. **Preparing cavities in the enlarged plaster teeth,** carved in the Dental Anatomy Technic Course.

Prepare several typical form pit and fissure and smooth surface cavities. The cuttings are to be made with vulcanite chisels and scrapers, after drawing the outline form with pencil. Deepen the convenience angles with hatchet and hoe excavators and chisels.

In case no enlarged plaster teeth are carved in the Dental Anatomy Course, excellent preliminary cavity preparation work may be done on the models here illustrated, Figs. 170 and 171, which the author has found very valuable in his own classes. The teeth were first carved in modelling composition from Black's average measurements, enlarged five times. From these, sectional plaster molds were made, which were then duplicated in Babbit's metal, from which the plaster teeth were obtained. The bases in which the teeth are mounted were made in the same manner. The teeth are removable.

3. **Preparing cavities in the ivory teeth** carved in the Dental Anatomy Technic Course. Typical cavity forms are made with the chisels, hatchets and hoes.

4. **Preparing Cavities in Extracted Teeth.**[1]—First, soak the teeth in glycerin one part and water two parts, to render them less brittle. Select teeth with cavities of decay and prepare

[1] **Splitting Natural Teeth.**—The exercises in the filing and sawing of sections performed in the Dental Anatomy technic course have impressed upon the student's mind the thickness of the enamel and dentin in different locations, as well as the degree of proximity of the pulp chamber to the surface when approached from various directions. To still further aid him in gaining a proper idea as to the depth of his cavity walls in relation to the pulp and to the surface, natural teeth may be split in various directions and these points more thoroughly studied, as suggested by Dr. A. E. Webster.

typical cavities, with the same instruments as indicated above. Avoid exposure of the pulp, and, in chiselling enamel, cut in the direction of the rods, finally bevelling in the various locations to avoid leaving any unsupported rods.

5. **Preparing Cavities in the Typodont or Odontotype.**—Practise the proper rests and guards.

CHAPTER IV

FILLING MATERIALS

Filling.—A material so placed in the prepared cavity of a tooth that the physiological and mechanical functions of the organ, its anatomical form, occlusion, contact point and esthetic appearance are properly restored or preserved, and the cavity itself protected as far as possible from future decay.

Attributes of an Ideal Filling Material.

1. Insolubility,
2. Harmonious color,
3. Adaptability to cavity walls,
4. Crushing resistance,
5. Freedom from molecular change,
6. Non-conductivity,
7. Capability of polish,
8. Convenience of manipulation.

1. **Insolubility.**—The mouth frequently contains, in addition to the watery constituents of the saliva, chemical substances, such as **acids,** which have a tendency to unite with and dissolve certain metals or their salts, as well as tooth structure; hence the necessity for the selection of a filling material which will resist the action, not only of water, but also of these chemicals.

2. **Harmonious Color.**—People of refinement and culture demand the use of a filling material which, where exposed to view, is harmonious in color, or at least presents a pleasing contrast to natural tooth structure, being as slightly con-

spicuous as possible. Those individuals who do not possess this attribute of correct appreciation of the **esthetic** should be educated in that direction by a high sense of the artistic displayed on the part of the **ethical** dentist.

3. **Adaptability to Cavity Walls.**—For filling teeth, materials should be selected which can be most perfectly adapted to the walls of the cavity and maintain that adaptation, in order that the cavity may be perfectly and permanently **sealed** against the entrance of moisture.

4. **Crushing Resistance.**—During the act of mastication, the teeth are subjected to a crushing **stress** ranging from 75 to 250 pounds' pressure, depending on the object incised or chewed, the teeth performing the work and the strength of the muscles of mastication. This being the case, the filling must possess the necessary resistance to strain and wear as well as **density, hardness, and tenacity,** to withstand this stress. The greater amount of the latter qualities it contains, the more "*edge strength*" it possesses when built out over long enamel bevels.

5. **Freedom from Molecular Change.**—All matter is composed of **atoms** united together in definite proportions to form **molecules.** These molecules possess certain characteristics, and have certain definite relationships to each other, as far as their shape, size, closeness of adaptation and position is concerned. In some metals, the molecules of which they are composed have a much greater tendency to change their relationship than others under certain physical conditions, such as **constant pressure, age, heat** and **cold.** Filling materials, under the conditions to which they are subjected in the mouth, should be especially free from this tendency to molecular change.

6. **Non-conductivity.**—The dentinal fibrillæ, when their ends are exposed, through loss of the enamel covering, conduct

to an exalted degree sensations of **heat, cold** and **electricity** when present in the mouth, to the pulp. The pulp rebels on reception of these sensations, responding in the form of a **paroxysm of pain.** This being the case, the ideal filling material should be a non-conductor, so that when placed, these sensations may not be transmitted through its substance.

7. **Capability of Polish.**—The highly polished condition of the enamel prevents, to quite an extent, the **accumulation of food** on its surface. Filling materials should be capable of taking a high degree of polish for the same reason.

8. **Convenience of Manipulation.**—Filling materials should be easily and conveniently manipulated, so that the operation may be completed **quickly,** and with as little **strain** as possible on patient and operator.

Classification of Filling Materials

The materials to be considered are Gold, Amalgam, Cement, Tin, Gutta-percha. None of these fill all of the above requirements, hence the ideal filling material has not yet been discovered. Gold, Amalgam and Tin may be considered as **Permanent** filling materials, as they have sufficient lasting qualities to be classed in that category, while Cement and Gutta-percha, owing to their short period of usefulness, are classed as **Temporary** filling materials. Another classification of filling materials is into **Plastic** and **Non-plastic.** The **Plastics** include Amalgam, Cement (zinc plastics) and Gutta-percha, these materials being worked while in a soft or plastic state, and hardening after being placed in position; the **Non-Plastics** including Gold and Tin, which do not possess this quality.

PLASTIC FILLING MATERIALS

Gutta-Percha—Cement—Amalgam

GUTTA-PERCHA

Origin.—The purified concrete juice obtained by tapping the Isonandra Gutta, an evergreen tree found principally in the Malay Peninsula and Archipelago.

Characteristics.—Color, almost white, or rose, or grayish white. Inodorous. Slightly elastic. It contracts on hardening or cooling. It is very bland and unirritating to the soft tissues, and is an absolute *non-conductor*. It in time becomes porous and disintegrates in unclean mouths. Freely soluble in chloroform, while oil of eucalyptus, eucalyptol and oil of cajeput have a softening effect on it. Heat softens it, but it hardens again on cooling.

Varieties of Dental Gutta-percha.—Gutta-percha is not used in dentistry in its pure state, but is combined with other materials to give it desirable working qualities. Of these, the principal ones are white wax, zinc oxid, or calcium oxid. Gutta-percha for dental use may be **classified** under one of the following headings:

1. Low heat—softens below 200° F. (1 part Gutta-percha, 4 parts Zinc Oxid).
2. Medium heat—softens from 200° to 212° F. (1 part Gutta-percha, 6 or 7 parts Zinc Oxid).
3. High heat—softens from 210° to 225° F. (Zinc Oxid to saturation).

There are a number of **varieties** of Gutta-percha in use for dental purposes, among which are the following:

1. Excelsior Gutta-percha—high heat—(softens at 225° F.).
2. Premium Gutta-percha—medium heat—(softens at 208° F.).

3. Superior Gutta-percha Stopping—high heat.
4. Flagg's Gutta-percha Stopping { Medium Heat, High Heat, Low Heat.
5. White Base Plate Gutta-percha—medium heat.
6. Pink Base Plate Gutta-percha—medium heat.
7. Hill's Stopping.

Formula: (Herman Prinz) { Feldspar 1 part, Quartz 1 part, Quicklime 2 parts, Gutta-percha base plate q.s. to make a stiff paste.

8. Temporary Stopping—(dressing seal)—low heat.

Formula: { White or Pink Base Plate 4 parts, Zinc Oxid 4 parts, White Wax 1 part.

Used for sealing temporary dressings.

9. Gutta-percha Points for Filling Canals.

Advantages of Gutta-percha.

1. Non-conductivity.
2. Ease of introduction.
3. Harmonious color (the white varieties).
4. Elasticity—(an advantage in making slow separation).

Disadvantages.

1. Low Crushing resistance. It cannot be used as a permanent filling material on surfaces exposed to mastication.
2. Subject to chemical action of lactic acid and sulfids in unclean mouths, readily disintegrating.
3. Shrinkage on cooling, with consequent tendency to draw from cavity walls.
4. Incapability of polish.

Uses.

1. As a temporary filling material in deciduous teeth.
2. As a more or less temporary filling material in unexposed cavities in permanent teeth.
3. For sealing in dressings.
4. For producing slow separation.
5. For filling root canals.
6. For temporarily setting crowns and bridges.
7. As a cavity lining and for filling small canals in the form of chloro-percha.

Chloro-percha is made by dissolving shavings of base plate gutta-percha in chloroform. On the evaporation of the chloroform the gutta-percha is left on the cavity wall or in the canal.

Method of Manipulation.—Give the cavity retentive form. Before insertion, the walls may be slightly moistened with eucalyptol, oil of eucalyptus, or oil of cajuput, preferably the first agent mentioned. Avoid overheating the gutta-percha, as the product is thus easily injured. Heating may be accomplished over the alcohol lamp, Bunsen burner, Flagg's Gutta-percha heater (Figs. 172 and 173), the thermoscopic heater, or on an electric annealer; then follow one of the following **methods.**

1. Cut the Gutta-percha into small pieces, soften with heat and pack each piece separately, condensing thoroughly with *cold* burnishers of suitable size. Avoid much excess, as the material is rather difficult to remove. Remove surplus material immediately with a *hot* flat spatula, trimming toward the margins. Smooth the surface of the filling with the same instrument, *slightly warmed*. If preferred, the filling may be allowed to cool and harden thoroughly, when the excess is removed with a *sharp* knife blade, but the knife must be very keen to avoid drawing the filling away from the margins.

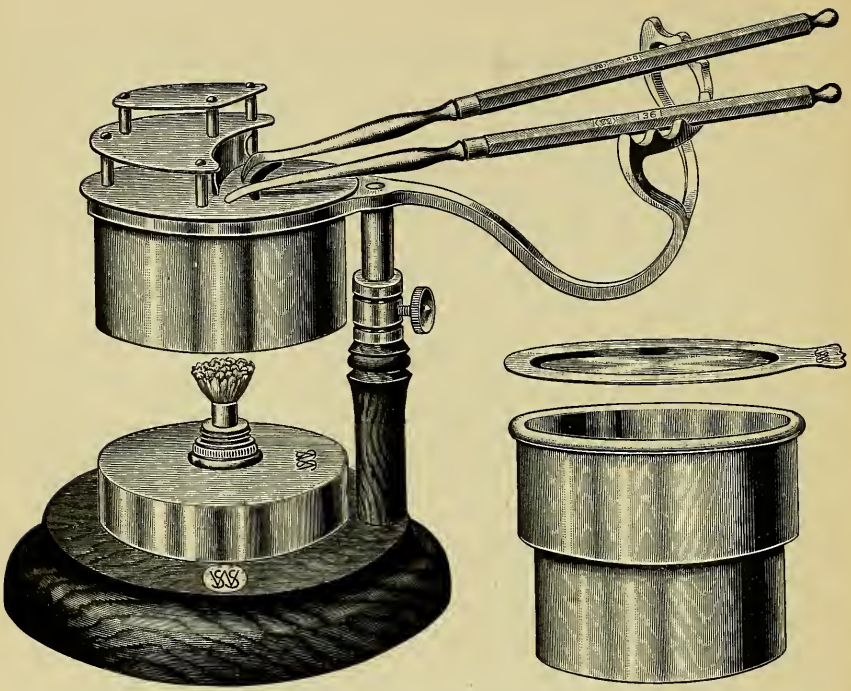


FIG. 172.—Flagg's gutta-percha and tool heater.

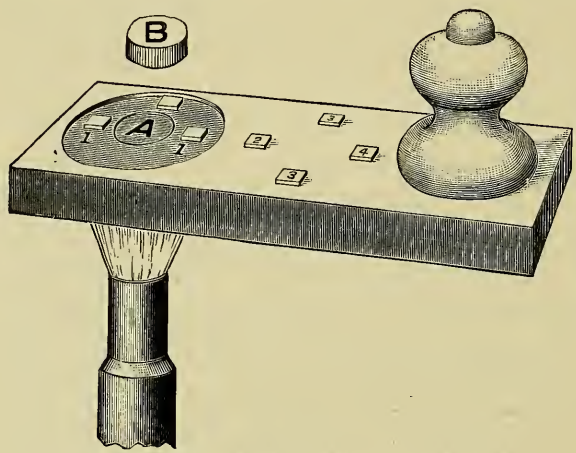


FIG. 173.—Thermoscopic heater for gutta-percha.

2. In cavities of easy access, heat the Gutta-percha and, while soft, mold into a mass of sufficient size to fill the cavity, packing with a *warm* burnisher, condensing thoroughly against the walls, and trimming the excess after either of the above methods. Then go over the surface of the filling with a pledget of cotton or spunk, moistened with chloroform. For illustrations of burnishers see Figs. 94 and 95.

Technical Exercises.

Fill several of the cavities, prepared during the study of cavity preparation, using both methods as outlined above.

CEMENT

There are four varieties of cements used in dentistry, each receiving a name depending on its chemical composition. Cements consist of a powder and a liquid, which when mixed together, form a more or less hard mass. The composition of these is largely a trade secret, but for all practical purposes it is as follows:

Classification of Cements

1. Oxyphosphate of Zinc (Basic Zinc Phosphates)	Powder, Zinc Oxid (calcined) Liquid, Phosphoric Acid
2. Oxyphosphate of Copper	Powder, Cupric Oxid Liquid, Phosphoric Acid
3. Oxychlorid of Zinc	Powder, Zinc Oxid (calcined) Liquid, Zinc Chlorid (deliquesced)
4. Silicates	Powder: Beryllium, Silicia, Aluminum, Calcium Compounds Liquid, Phosphoric Acid

Characteristics.—All of the cements are intended for *temporary* filling work, unless covered by some more permanent material, as they are more or less soluble in the oral fluids. (1) The *Oxyphosphate of Zinc* (basic zinc phosphates) is the most

important of these preparations, and most universally used. It may be obtained in various shades to harmonize with the color of the teeth, and is much more lasting than the oxychlorid. It is largely used for temporary filling work, for cementing crowns and bridges, inlays, orthodontia appliances, and as an **intermediate** (between the filling and cavity). (2) The *Oxyphosphate of Copper* (color inky black) is extremely sticky, and clings tenaciously to dry cavity walls. It is also **antiseptic** (against infection) in character, and markedly bland to sensitive cavities. For this reason it is used for filling cavities, pulp chambers and canals in temporary teeth; also cavities in permanent teeth whose sensitiveness will not permit of proper cavity preparation. On account of its color it has to be confined to posterior teeth. (3) The *Oxychlorid of Zinc* is now seldom used as a filling material, except in root canals, as it quickly disintegrates in contact with moisture. It is extremely **irritating** to vital tissues, and cannot be used in close proximity to the pulp, but is still utilized by some as an intermediate, on account of its antiseptic properties and its white color. (4) The *Silicate Cements*, recently introduced, are in a stage of experimentation. Great claims are made for them by their manufacturers as **permanent** filling materials, if properly handled; but there is a great variation in the results so far obtained by different operators. They are *translucent* and more nearly harmonize with the color and appearance of enamel than the other cements.

Advantages of Cements.

1. Non-conductivity (except silicates, most of which require an intermediate).
2. Harmonious color (except oxyphosphate of copper, which is black).
3. Adhesiveness to cavity walls (except silicates).
4. Ease of introduction.

Disadvantages.

1. Lack of edge strength.
2. Low crushing resistance.
3. Solubility in the fluids of the mouth.
4. Incapability of polish (except silicates).
5. Change of molecular form while setting (some expand, some shrink).

Method of Mixing Cements.—Use a *clean* glass slab (Fig. 174), with a heavy, German silver, steel, or agate spatula (see Fig. 96), preferably German silver, which is less readily acted upon by the liquid. For the silicates, no steel instruments can be used in the mixing or packing, on account of chemical action, and consequent discoloration of the mass. Tantalum, agate, ivory, or tortoise-shell instruments are recommended. The oxychlorid of zinc and oxyphosphate of copper are mixed to a creamy consistence; the oxyphosphate of zinc to the consistence of putty for filling, and to a creamy consistence for setting crowns, inlays and regulating appliances. The silicates are mixed stiffer than the oxyphosphate of zinc, working in all the powder possible, which will be greater in amount than that taken by the liquid of the zinc phosphate cements.

FIG. 174.—Glass cement slab.

Directions.—(1) Place, by means of a glass rod or pipette, the necessary amount of liquid in the center of the *clean* slab. (2) Deposit, by tapping the bottle, or with a clean spatula or other convenient carrier, the necessary amount of powder at one end of the slab. (3) Draw in one-fourth of the powder and spatulate thoroughly with a swinging, circular movement. (4) Then draw in another one-fourth of the powder and spatu-

late as before until thoroughly mixed, continuing to add the powder, and spatulating until the mix is of the desired consistency. (5) For fillings, the mixing should be continued until the cement materially resists spatulation, when it is scraped from the slab, and in some instances rolled into a ball ready for use. Directions accompanying the package specify minute details of mixing silicates and other cements, these varying to some extent, depending on chemical composition.

Method of Packing.—The cavity should be **dry,** with slightly retentive form and bevel not marked. Pack in small pieces, thoroughly condensing with as much force as the material will allow, by means of smooth burnishers, leaving an excess for polishing. As soon as the material is molded to form, allow it to set thoroughly before removing the excess and polishing. Trim and polish with knives, disks and strips, in the case of the silicates finishing with celluloid strips. The use of the **matrix** is a necessity in complex cavities, if the best results are desired.

Hydraulic cements require the application of water after molding to form, and before setting.

Intermediates

Sensations of heat and cold are rapidly transmitted, by means of the dentinal fibrillæ, to the pulp from the walls of cavities, and as the permanent filling materials are conductors of these physical forces, it becomes necessary in all cavities, except extremely shallow ones, to place **non-conducting substances** between the filling and the walls of the cavity. These materials are known as *intermediates*, and the act of placing them in position is known as **Pulp Protection.** The substances most frequently used are Cement and Gutta-percha. Cement itself is a slight conductor, so that in

extreme cases of hypersensitivity a thin layer of Gutta-percha, Chloropercha, or one of the **Cavity Linings,** is applied, and then covered with cement, when the balance of the filling is placed in position. **Cavity Linings** are colorless, transparent liquids, which, on evaporation, leave a thin, non-conducting film on the walls of cavities. Two prominent varieties of these are *Cavitine* and *Gilbert's Cavity Lining.*

Technical Exercises.

1. Carefully mix a batch of cement, according to the directions given above, stirring in small amounts of the powder at a time, and spatulating *thoroughly* to accomplish mechanical and chemical union of powder and liquid. Roll into a round mass.

2. Mix another batch by adding the powder in large amounts, and avoiding thorough spatulation. Roll into a mass as in No. 1.

3. Place the two mixes in ink or aniline dye for twelve hours, and then compare for cutting consistence as well as amount and penetration of the stain.

4. Insert several cement intermediates in the cavities already prepared, building some up in **step form.**

5. Insert several cement fillings, with and without **matrices.**

AMALGAM

Definition.—*An alloy or union of mercury with one or more other metals.* Most dental amalgams consist of a combination of mercury with silver, tin, copper or zinc. To these are also sometimes added gold, platinum and other metals.

Alloy.—*A union of two or more metals by means of heat.* The metals are usually melted in a closed electric crucible in an atmosphere of hydrogen. After cooling and hardening,

the resultant mass is known as an **Ingot.** The ingot is either filed into small granules or pared into fine shavings, when, after being annealed and carried through certain other processes it is dispensed as alloy for dental use.

Properties of Amalgam

All dental alloys, when mixed with mercury, possess one or more of the following properties, which are imparted to the mass by qualities inherent in the constituents, viz.,

1. Spheroiding.
2. Flow.
3. Shrinkage.
4. Expansion.

Spheroiding.—The tendency to become **round** imparted to the mass by the mercury. It only occurs while the amalgam is hardening or setting, and depends on the amount of mercury left in the mass, the greater the excess of mercury present, the more marked the spheroiding.

Flow.—Many metals, when subjected to constant stress, as from the stress of mastication, possess the tendency to slowly **move from under the stress,** thus gradually changing their shape. Some, notably tin, possess more of this property than others.

Shrinkage and Expansion.—Some metals, when heated or **amalgamated** (mixed with mercury), shrink, while others expand. The ideal amalgam would be one in which the constituents are so combined as to possess neither of the above qualities, and has not as yet been discovered.

Amalgams possess, in addition to the above qualities, certain advantages and disadvantages.

Advantages.

1. Crushing resistance.
2. Insolubility.

3. Convenience of manipulation.
4. Capability of polish.

Disadvantages.

1. Inharmonious color.
2. Tendency to molecular change.
   (a) Spheroiding.
   (b) Flow.
   (c) Expansion.
   (d) Shrinkage.
3. Lack of edge strength when built to thin edges.
4. High conductivity.

Metallurgical Properties of Silver, Tin, Copper and Zinc

The various metals in dental alloys possess certain properties, some of which they impart to the mass when combined with mercury. Some desirable qualities of one metal overcome certain undesirable ones of another in the combination, if the metals are combined in the correct proportions.

Silver.

1. Unites with mercury fairly readily in definite atomic proportions.
2. Tarnishes.
3. Expands.
4. Retards setting.
5. Increases edge strength.
6. Lessens flow.
7. Works hard.

Tin.

1. Unites readily with mercury in all proportions.
2. Retards setting.
3. Increases flow.
4. Imparts plasticity.
5. Shrinks.
6. Decreases edge strength.

Copper.

1. Unites with mercury with difficulty in definite atomic proportions.
2. Hastens setting.
3. Increases edge strength.
4. Lessens flow.
5. No appreciable expansion or contraction.
6. Tarnishes readily.

Zinc.

1. Unites easily with mercury in definite atomic proportions.
2. Expands.
3. Hastens setting.
4. Diminishes edge strength.
5. Increases flow.
6. Improves color.
7. Imparts plasticity.

Classification of Amalgams

Amalgams may be classified according to the number of constituents they contain into:

1. Binary—one containing mercury and one other metal. Example, copper amalgam.

2. Ternary—one containing mercury and two other metals. Example, Townsend's amalgam, containing mercury, silver and tin.

3. Quaternary—one containing mercury and three other metals (Black's amalgams). Example, mercury, silver, tin and copper.

4. Quinary—one containing mercury and four other metals. Example, mercury, silver, tin, copper and zinc. Most of the amalgams in use today are either Quaternary or Quinary amalgams.

Classification of Alloys

Alloys may be classified into two divisions, as follows:

1. **High-percentage,** or **Quick-setting Alloys** (containing a high percentage of silver).

Formula: Silver	65 to 68	per cent
Tin	26 to 28	per cent.
Copper	3 to 4.5	per cent.
Zinc	1 to 2.5	per cent.

Properties.—(1) Quick setting. (2) Hard working (lack of plasticity). (3) Great crushing resistance and edge strength. (4) Stability of form (minimum of shrinkage, expansion and flow). These alloys are sometimes designated Dr. Black's alloys, but they are wrongly named, as they do not follow his formulæ.

2. **Low-percentage, Slow-setting** or **Plastic Alloys.**

Formula: Silver	43 to 48	per cent.
Tin	48 to 58	per cent.
Zinc	1 to 2	per cent.

Properties.—(1) Slow setting. (2) Lighter in color. (3) Plasticity (easy working). (4) Less crushing resistance and edge strength. (5) Greater shrinkage, expansion and flow. (6) Require less mercury to amalgamate.

Amalgam, on account of its inharmonious color, should be confined to the posterior teeth.

Method of Mixing.—The proportion of mercury to the alloy varies in different formulæ and is obtained by testing the batch, or from printed directions on the package. The average is about five parts of alloy to seven parts of mercury by weight. Rapid-setting alloys usually require more mercury. To prevent change of form and to give the greatest edge strength, *all excess* of mercury must be removed in mixing.

Directions.—(1) Place the desired amount of alloy in a wedgewood or glass mortar, preferably the latter, and add the

necessary amount of mercury by weight. (2) Mix thoroughly with the pestle (Fig. 175) until the alloy and mercury are completely incorporated. (3) Remove to the *dry* and *clean* palm of the left hand and work vigorously, rapidly and continuously with the fingers of the right hand for from three to five minutes, squeezing frequently and removing excessive mercury until a characteristic *cry* of the mass is heard when in close proximity to the ear. (4) With the thumb and forefinger, forcibly squeeze out all remaining excess of mercury; or

FIG. 175.—Glass mortar and pestle.

transfer it to a piece of cloth or chamois and wring with a pair of pliers. Pack immediately.

Method of Packing.—Cut the mass into several small pieces (depending on the size of the cavity) with a flat burnisher. Do not use too large pieces. Pack with *serrated* amalgam pluggers, Black's or Ivory's (Figs. 91 and 92). Do not use smooth burnishers. Pack with steady, forcible hand pressure, condensing thoroughly one piece at a time. Pack toward the walls, **wedging** the several pieces between each other and the walls. If any excess of mercury appears on the surface during the packing and **wedging** process, remove it

with spoon or discoid excavators before continuing. Do not use tin foil or gold foil for this purpose on account of the danger of forming a new alloy, possessing new properties. Pack the cavity *overfull*, and allow the mass to set for several minutes before removing the excess. Trim the excess with flat burnishers and knives *toward* the margins, leaving the filling carved to full contour on proximal surfaces, and to proper form on others. The final polishing is deferred for twenty-four, or better forty-eight hours, to allow for complete setting. Directions for polishing are given on page 159.

Cavity Preparation for Amalgam Work varies very little from that for gold. The various steps as described in the chapter on cavity preparation should be carefully and conscientiously completed. Convenience angles are not necessary for starting the filling, the usual retention and resistance form being all that is necessary. Owing to its **lack of edge strength,** the amount of bevel of the cavo-surface angle should be modified as much as conditions will allow.

Matrices.—For filling with amalgam, the presence of four lateral walls to the cavity is a necessity, to prevent the squeezing out of the mass during the application of the great force required during the packing process. In cavities lacking four walls, the missing wall is supplied by the use of a thin metal band of steel or German silver in the form of a matrix. For technic purposes in the laboratory, a thin band of German silver, 2/3 or 3/4 the circumference of the tooth, may be tied in position by means of floss silk, or binding wire, encircling the tooth several times. If the exercises in filling are performed on natural teeth, with extensive cavities, a measurement of the neck of the tooth may be taken, and a soldered band made to completely encircle the tooth.

Technical Exercises.—Fill the cavities in the posterior teeth prepared during the studies in cavity preparation.

NON-PLASTIC FILLING MATERIALS

Tin—Gold

TIN

Characteristics.—Tin, when pure and freshly cut, is **cohesive** (the separate particles clinging to each other), like gold. It rapidly loses this property, though, on exposure to the atmosphere, and gradually becomes **non-cohesive.** Until recently it was worked almost exclusively after the non-cohesive method. There have recently been introduced several preparations of tin which are very cohesive, one of which is known as **Duplex,** a cohesive tin covered with cohesive gold. Another, which receives the trade name of **Crystallia,** is prepared in coarse silver-colored shreds.

Tin is very little used as a filling material today. It may be utilized in the technic laboratory for experimental purposes, as a substitute for gold. For working on the cohesive principle, it may be prepared for use after the following **method.** Take a corundum wheel, 1 3/4 to 2 1/2 inches in diameter, and make a mold in sand or marble dust. After removing the wheel, pour melted pure tin into the impression in the sand or marble dust, thus duplicating the wheel in tin. Mount on a mandrel on the laboratory lathe, and, while revolving rapidly, cut fine shavings with a sharp carpenter's chisel. These shavings, if worked while freshly cut, will be very cohesive.

Tin is placed on the market in sheets 4 inches square, the same sizes and numbers as gold foil, ranging numbers 2, 3, 4, 5, 6, 8, 10, 20, 30, 40, 60 and 120. It is prepared by the manufacturer in the same manner as gold, by rolling an **ingot** into strips and then rolling thinner for the higher numbers, and beating by machinery for the lower numbers. The num-

ber indicates the number of grains to the sheet, viz., a sheet of No. 4 foil weighs 4 grains, No. 10 weighs 10 grains, etc.

Tin foil, as well as gold foil (cohesive or non-cohesive) is prepared for use in various forms by the operator or his assistant.

The principal forms used are:

1. The Roll.
2. The Ribbon or Tape.
3. The Rope.
4. The Cylinder.
5. The Mat or Cushion.

Method of Preparing. (Either tin or gold.)

1. **The Roll.**—(a) Cut a sheet of foil into quarters, thirds or halves, and place a section near one end of a smooth towel, which has been folded lengthwise. (b) Pull the other end of the towel over the foil, and then, bringing it in contact with it, quickly push the towel from you in such a manner as to roll the foil into a loose roll. (c) Repeat the process until the roll is as small as desired (Figs. 176 and 177).

2. **The Ribbon.**—(a) Cut the foil into halves, thirds or quarters, as before, and lay a section on a folded towel or napkin, chamois or spunk, held in the left hand. (b) With a large, clean, plaster spatula, or preferably a **gold folder,** fold the foil lengthwise by placing the folder in the center of the section, and bringing together the folds of the towel, or other article used, by closing the hand. (c) Repeat the operation, continuing to fold smaller and smaller, until the ribbon is the desired width (Fig. 178).

3. **The Rope.**—(a) Twist a quarter, third or half sheet of foil into a rope between the clean and dry **thumb and fingers** of both hands, being careful to make the rope as near an equal size throughout its length as possible. The fingers may be

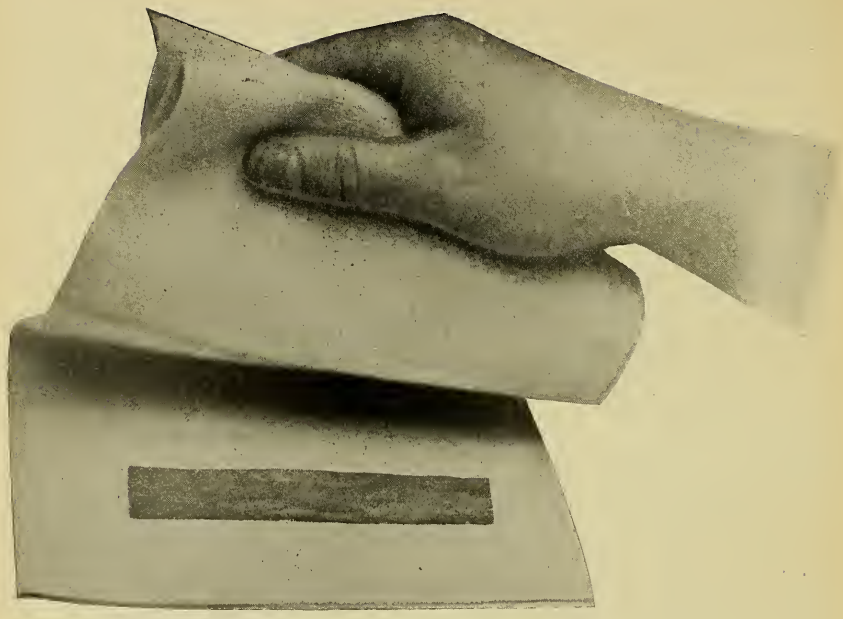


FIG. 176.—Making the roll.

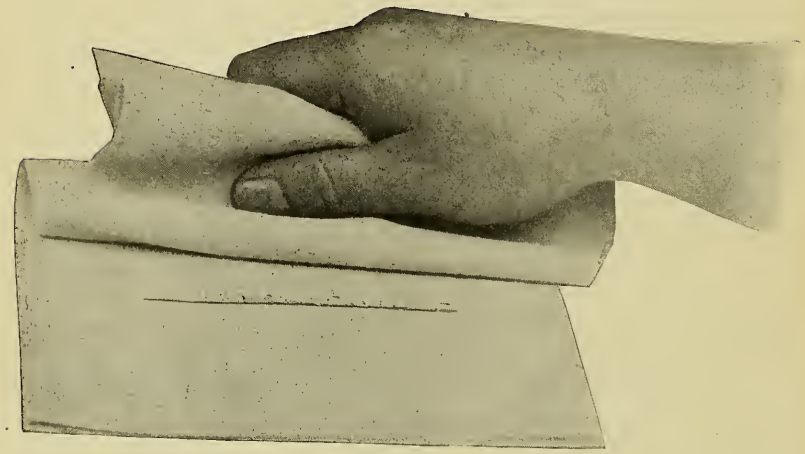


FIG. 177.—The roll completed.

covered with finger cots, if the hands are moist. This method is hardly applicable to cohesive gold.

4. **The Cylinder.**—Roll a ribbon on a three-, four- or five-sided **smooth broach** into a cylinder. The size of the cylinder will be regulated by the *length* of the ribbon, and the length of

FIG. 178.—Folding the ribbon.

the cylinder by the *width* of the ribbon. Various sizes and lengths are required, depending on the size and depth of the cavity. Gold cylinders in both **cohesive** and **non-cohesive** forms are also prepared ready for use by the manufacturer (Fig. 179).

5. **The Cushion or Mat.**—Fold a ribbon lengthwise upon itself with a **spatula,** until made into a mat or cushion. The

size will depend on the size of the cavity, and may be varied by regulating the width of the ribbon, the amount of gold used and the number of folds.

Another Method.—Roll a cylinder on a flat-sided broach,

FIG. 179.—Making the cylinder. The broach and cylinder are shown much enlarged.

and then, after withdrawal from the broach, flatten it more; or roll the cylinder as usual and flatten into a mat.

Advantages of Tin.

1. Non-conductivity. (Lowest of all the metals.)

2. Ease of introduction. (Works rapidly when non-cohesive.)
3. Adaptability to cavity walls.
4. Therapeutic action. (Supposed by some to prevent decay.)
5. Capability of polish. (It takes a high polish, but does not retain it.)

Disadvantages.

1. Inharmonious color. (Oxidizes and darkens readily.)
2. Lack of crushing resistance and edge strength.
3. Flow.
4. Disintegrates in the fluids of the mouth.

Tin is still used by some operators for filling cavities in **children's teeth** on account of its ease of introduction and supposed therapeutic effect; also in **rapid caries** on surfaces unexposed to view and mastication. It is too soft to be subjected to the forces of occlusion in permanent teeth. As the method of working non-cohesive gold and tin is identical, the description here given will apply to both materials.

Method of Working Tin or Non-cohesive Gold.—The cavity preparation is practically the same as for cohesive gold, except that deepening of the convenience angles is omitted, and, owing to lack of edge strength in the material, enamel bevels should not be so acute. Simple cavities with four strong walls are a necessity. All filling materials are packed more or less after a process of **wedging,** but the wedging principle is carried to its fullest extent with non-cohesive gold and tin. Owing to the fact that neither of these possesses the property of cohesion, as the other filling materials do, they are mechanically wedged into the cavity with great force, so that each lamina or layer is dependent on the other to retain it in place. The packing is done with hand pressure, by means of serrated, wedge-shaped pluggers, the final

condensation being accomplished by means of mallet force. Owing to the strength of the thrust required for working tin and gold by the non-cohesive method, larger handles than

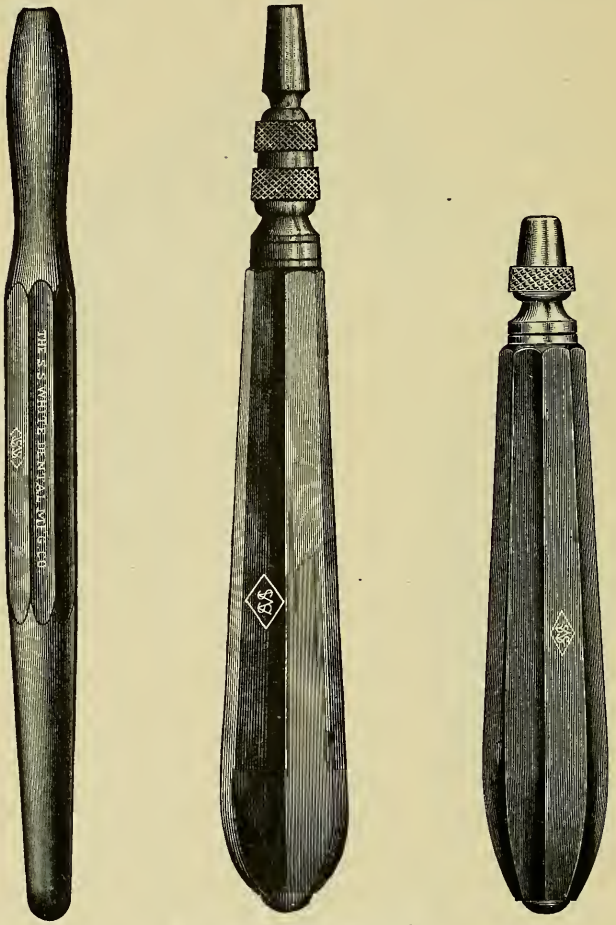


Fig. 180.—Plugger handles.

those usually employed are necessary (Fig. 180).

Two methods are employed, depending on the size of the cavity and the individual preference of the operator.

1. **The Cylinder or Cushion Method.**
2. **The Ribbon, Roll, or Rope Method.**

1. **The Cylinder Method.**—The cylinder method is the more rapid when the size of the cavity will admit of its adoption. The cylinders should be of such length that one end will protrude above the orifice of the cavity, while the other rests on the floor or seat. (Fig. 181).

(1) Place enough cylinders against the wall farthest away from the operator to cover the wall. Condense thoroughly against the wall with the plugger.

(2) In large cavities place another layer of cylinders against

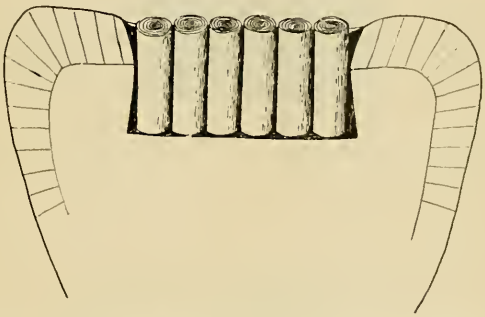


FIG. 181.—Working gold or tin cylinders (non-cohesive).

the first layer, and condense in the same direction, holding in position with a plugger in the left hand.

(3) Repeat the procedure on the opposite wall, and then on the two intervening walls, leaving the center of the cavity unfilled.

(4) Force one or more cylinders into the central opening, the number depending on its size, ramming them in until the cavity is full.

(5) Force an opening, by means of the wedge-shaped pluggers, into another part of the filling, and pack in one or more smaller cylinders here, repeating this process at other

points until it is impossible, by great force, to insert any more cylinders.

(6) Thoroughly condense with foot pluggers by means of mallet force and then burnish.

(7) Trim to shape, grind to shape, or file to shape and burnish again, continuing until the filling is of proper fullness; then polish. Directions for polishing fillings are given on page 159.

2. **The Ribbon Method.**—This method is practically the same as the preceding, except that instead of the use of cyl-

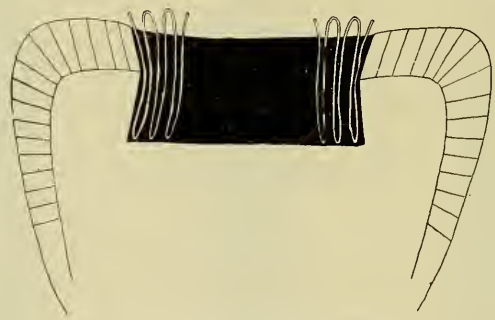


Fig. 182.—The ribbon method.

inders, long ribbons, rolls or ropes are folded upon themselves, starting on the floor of the cavity, against the lateral wall farthest away, and gradually condensing ribbons against all four walls, then in the center, and finally in any place they can be wedged, always carrying the ribbon to the floor of the cavity, and extending it well above the margins to allow enough excess for finishing (Fig. 182).

Technical Exercises

1. Prepare rolls, ropes, ribbons, cylinders and mats or cushions, according to the directions previously given.

2. Fill the *simple cavities* prepared in the bone handle, using for one, the rolls; for another, the ropes; for the third,

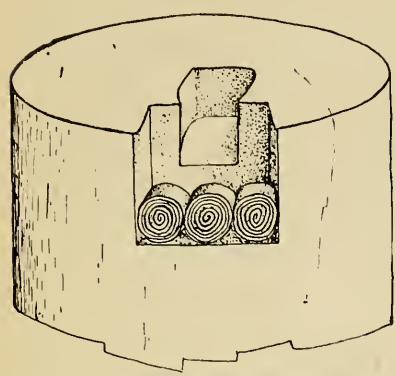


FIG. 183.—Filling the step cavity in the end of the bone handle with cylinders (non-cohesive). Adapting the cylinders to the seat.

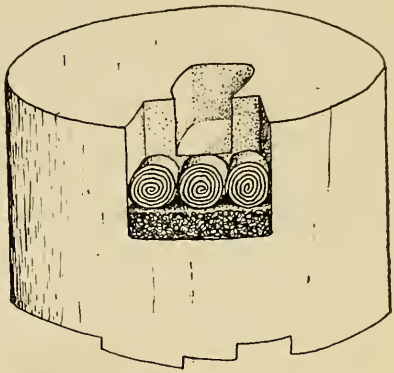


FIG. 184.—Building the non-cohesive cylinders to the level of the step. The matrix is not shown.

the ribbons; the fourth, the cylinders; and the fifth, the cushions.

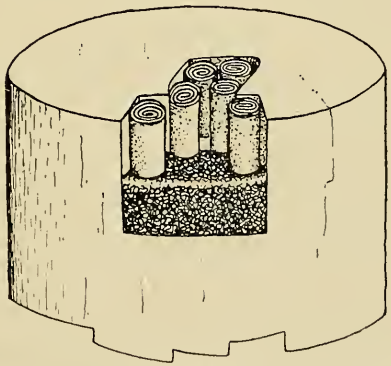


FIG. 185.—The direction of the cylinders is changed and the rest of the filling completed in the manner illustrated.

3. (a) Take a measurement of the circumference of the handle at the end containing the *compound mortise form*, and from thin German silver construct a matrix to be used in

filling this cavity. (b) Place the matrix in position and fill the cavity with cylinders.

Directions.—(1) Prepare cylinders large enough for three of them to cover the *seat,* when condensed against that wall, and slightly longer than the distance from the matrix to the imaginary axial wall, when laid on the seat, with one end toward the matrix and the other toward the axial wall. (2) Place the cylinders in position, and condense with wedge-shaped, serrated hand pluggers, wedging the middle one in between the other two (Fig. 183). (3) Place in more cylinders, and continue thus until the filling is nearly on a level with the top of the step (Fig 184). (4) Fill the balance of the cavity as if it were a simple cavity, laying the cylinders in the opposite direction to that used in filling the first portion of the cavity, viz., with one end lying on the step and on that portion of the filling already condensed, and the other end pointing toward the end of the handle (Fig. 185).

4. Burnish and polish all of the fillings.

GOLD

Characteristics.—Gold, for filling cavities, should be pure. In its pure state, uncontaminated, it is cohesive. By **cohesiveness** is meant the property which causes separate particles, when brought in contact, to cling to one another. Gold possesses this property to a higher degree than any other metal. It is taken advantage of in building fillings, by **welding** the various pieces together in the cold state, by means of the plugger. Gold and tin are the only metals possessing to any degree this property of cohesiveness or weldability in the cold state.

Classification.—Gold, for filling purposes, is classified into two varieties, as far as its minute or microscopic structure is concerned.

1. **Fibrous gold.**
2. **Crystalline gold.**

If these two forms be examined under the microscope, the **fibrous** forms are seen to consist of numerous fibers interlacing each other in every direction; while the **crystalline** forms appear more granular in character. For this reason the fibrous forms make the stronger fillings, although they have a tendency to draw away from cavity walls while being manipulated, owing to a certain amount of resilience or spring in the fibers. The crystalline forms do not possess this tendency, and are more easily manipulated, but are *deceptive and treacherous preparations for students' use* on account of their easy working properties.

1. **Fibrous Gold.**—Fibrous golds are supplied in the form of foil or sheets 4 inches square, ranging number 2, 3, 4, 5, 6, 8, 10, 20, 30, 40, 60 and 120. The higher numbers are rolled out by the manufacturer from an **ingot,** while the lower numbers are beaten by machinery.

Fibrous gold is classified into (a) **Cohesive;** (b) **Semi-cohesive;** (c) **Non-cohesive.**

(a) The **cohesive foils** are, after being rolled or beaten, annealed by heat and put up in books containing 1/8 oz. Before using, the dentist usually re-anneals them, as they will in time lose much of their cohesive property on exposure to the atmosphere, accumulating gases, which may be driven off by heat.

(b) The **non-cohesive foils** have deposited on their surface certain substances, such as iron, sulphur, or phosphorus, which destroy their cohesive property.

(c) Some foils are supplied as **semi-cohesive,** in which the cohesive property is not developed to its fullest extent. These are preferred by some operators. The non-cohesive

and semi-cohesive forms are also supplied in 1/8 oz. books, the numbers running the same as the cohesive foils.

2. **Crystalline Gold.**—There are many varieties of this form made by various manufacturers, all of which are highly cohesive, and receive different names. *Watt's Crystal Gold*, *Solila*, and *Corona* are preparations supposed to be both fibrous and crystalline in nature. These preparations are not in sheet form, but are supplied in strips, bricks, mats and similar shapes.

Advantages of Cohesive Gold.

1. Insolubility.
2. Adaptability to cavity walls.
3. Great crushing resistance and edge strength.
4. Freedom from molecular change.
5. Capability of polish.

Disadvantages.

1. Color.
2. High conductivity.
3. Difficulty of manipulation.

It will be seen that cohesive gold more nearly fills the requirements of an ideal filling material than any other substance yet introduced, its chief disadvantage being its objectionable color. Until something less conspicuous, having the necessary lasting qualities, is introduced, though, it will continue to maintain, as it has in the past, its position as **King** of filling materials.

Indications for Use.—Gold may be placed in any portion of the mouth where proper access may be obtained, where its color is not objectionable, and the strength of cavity walls permits.

Non-cohesive gold may be used, on account of its **rapidity of manipulation,** in simple cavities with four strong walls, located on surfaces not subject to wear. It may also be used

in combination with cohesive gold, for beginning fillings on the gingival wall in proximal cavities, or on the pulpal or axial wall in others, as a time-saver. It is not indicated on surfaces subjected to the stress of mastication, or for contour work. **Cohesive** gold, though, is now used **almost exclusively,** on account of its great crushing resistance, its ability to contour and to be built out over long bevels to thin edges, and also on account of greater familiarity on the part of modern operators with its working properties.

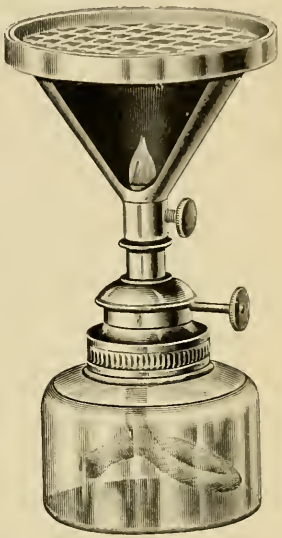


FIG. 186.—Kerr flame shield and gold annealer with alcohol lamp.

METHOD OF WORKING COHESIVE GOLD

Annealing.—Annealing is for the purpose of driving off volatile surface impurities, and rendering soft. There are **two methods,** as follows, *viz.*,

1. Cut the gold into small pieces, and lay on the tray of a **gold annealer,** thus preventing contact with the impure gases of the flame, as well as the tendency to overheating and irregular annealing. The best form of annealer is the electric, though good results are obtained with the ordinary forms, constructed for use on the alcohol lamp or Bunsen burner (Fig. 186).

2. Grasp the gold near one end with foil carriers, and pass back and forth over the **flame of an alcohol lamp** or Bunsen burner. Then grasp at another point, and repeat the procedure, heating the gold to a dull red color, being careful not to overheat or melt any portion. There are *three disadvantages* in this method. (a) The danger of overheating or melt-

ing the gold, rendering it brittle and destroying its softness. (b) The danger of overheating one part and underheating another. (c) The danger of gases from an impure gas flame, or a charred wick of an alcohol flame, destroying some of the natural cohesive property of the gold. The point first grasped by the pliers is not annealed because the handles of the pliers carry off the heat at that point, hence the necessity of grasping at a new point after the first annealing, and repeating the process to prevent the occurrence of partially annealed spots in the gold, with the resultant tendency to *pitting* in the filling.

The use of a gold annealer is the most satisfactory method. If a mica or soapstone tray is used, the student should be careful to see that the flame of the lamp is given sufficient heat to properly anneal the gold, else poor fillings from failure to bring out its full cohesive property will be the result.

Gold Pluggers.—Gold pluggers are made with numerous serrations in their face, these serrations being of a wedge or pyramidal shape. A set of gold pluggers should possess serrations of the same size in each instrument, in order that when change of instruments is made during the gold-building operation, the pyramids may properly **interdigitate** (see Figs. 88, 89 and 90). In case instruments with different size serrations are used, when a change to a new instrument is made, the surface of the gold should be gone over with the new instrument before adding a fresh piece of gold.

There are three principal **methods of plugging** cohesive gold:

1. By means of hand pressure.
2. By the use of the hand mallet.
3. With some form of mechanical mallet.

For *starting fillings*, hand pressure alone should be used, while for *building the main body* of the filling, either the hand mallet or some form of mechanical mallet is utilized. For

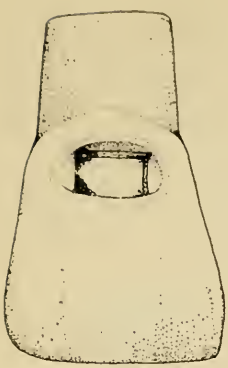


FIG. 187.

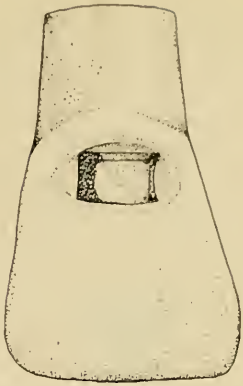


FIG. 188.

FIG. 187.—Series of illustrations showing the steps in filling a "gingival third" cavity on an incisor with cohesive gold. The cavity form is more clearly illustrated in Fig. 141, a box-shaped cavity with four definite point angles. First, fill two of the point angles.

FIG. 188.—Then build gold along the connecting line angle, uniting that first placed in the two convenience angles.

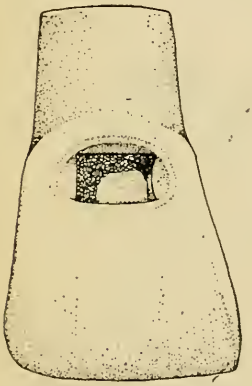


FIG. 189.

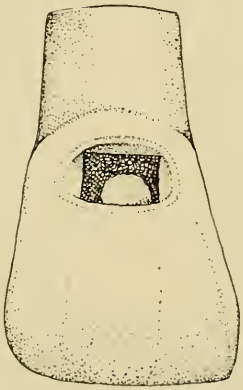


FIG. 190.

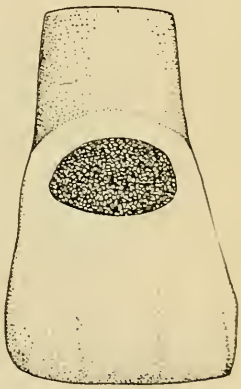


FIG. 191.

FIG. 189.—Carry the gold along the gingivo-axial line angle over into the mesio-gingivo-axial point angle, anchoring it there.

FIG. 190.—Then build along the mesio-axial line angle over into the mesio-inciso-axial point angle, completely filling the latter.

FIG. 191.—Continue the process as outlined in the previous illustrations and completely fill the cavity, building to proper fullness and making sure that the margins are covered.

operations in the technic laboratory, the student may confine himself to hand pressure and the hand mallet, as very excellent work may be done by this method, although, if desired, the automatic mallet may be used in addition. The operations may be performed with **cohesive tin** instead of gold, and excellent practice obtained in that manner. The student should perform, though, at least a few gold-building operations (Figs. 187, 188, 189, 190 and 191).

General Directions for Proximal or Proximo-Occlusal Cavities

1. Take up a small piece of gold, and carry it by means of the foil carriers, into the **point angle** farthest distant, holding it in position with a gold holder in the left hand.

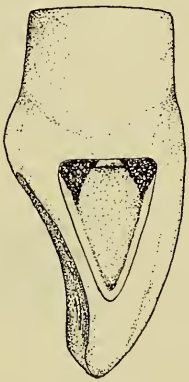


FIG. 192.

FIG. 193.

FIG. 192.—Stages in filling a proximal cavity on an incisor tooth with cohesive gold. First fill the linguo-axio gingival and the labio-axio-gingival point angles with a half millimeter plugger by means of hand pressure.

FIG. 193.—Unite the two portions of gold by building along the gingivo-axial line angle. Then change to a 3/4 millimeter plugger and condense with mallet force.

2. **Condense thoroughly with hand pressure,** by means of a half millimeter gold plugger, directed equally toward the three walls forming the point angle, continuing to hold in

position with the gold holder until the point angle is filled, when, if the angle is properly prepared, the gold will remain where placed (Fig. 192).

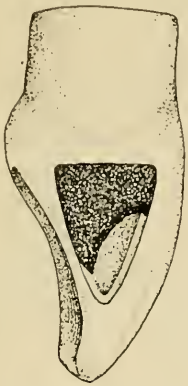


FIG. 194.

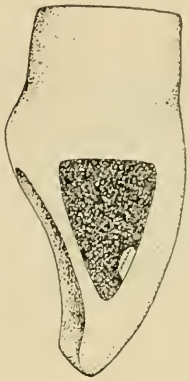


FIG. 195.

FIG. 194.—Build the gold out to full contour along the axial wall, keeping the lingual portion in advance.

FIG. 195.—Fill the incisal point angle and unite it to the main body of gold, completing the filling on the labial side.

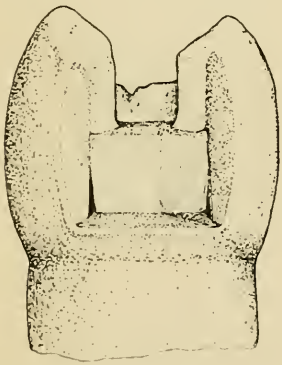


FIG. 196.—Proximo-occlusal cavity in a bicuspid tooth, prepared for a gold filling.

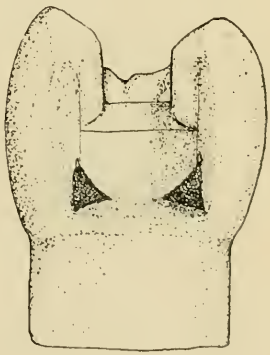


FIG. 197.—The gingival point angles filled.

3. Repeat the same procedure in the opposite convenience angle (Fig. 192).

4. Build the gold **along the connecting line angle,** con-

densing equally against the two walls which form the line angle (Fig. 193), when the gold is now thoroughly anchored in position.

5. Changing to a 3/4-millimeter, or 1-millimeter plugger,

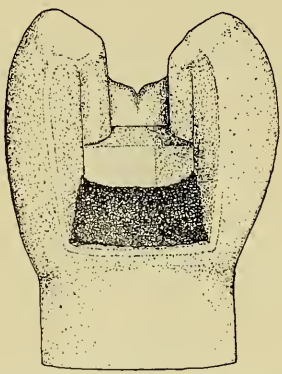


FIG. 198.—The gingival wall covered.

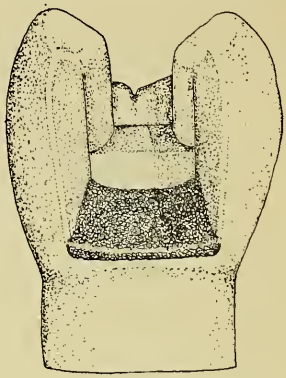


FIG. 199.—Building along the axial wall.

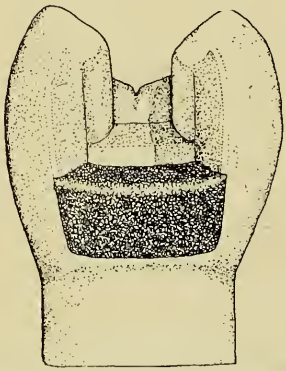


FIG. 200.—The top of the step nearly reached.

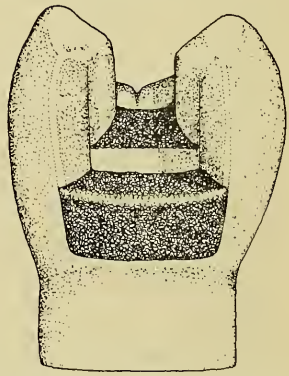


FIG. 201.—Covering the pulpal wall (the step).

depending on the size of the cavity, **condense thoroughly** with **hand mallet, or other form of mallet.**

6. Build the gold along the **axial** wall in proximal cavities not involving the angle, until the other point angle is reached,

when it is filled separately as before with **hand pressure,** then condensed with the **mallet** and afterward united to the main body of gold (Figs. 194 and 195). In proximo-occlusal cavities the same procedure is followed until the top of the step is reached. Then fill the convenience angles separately at the **far end of the step,** later uniting them, and then building the gold across the step and uniting it with the first portion of the filling (Figs. 196, 197, 198, 199, 200 and 201).

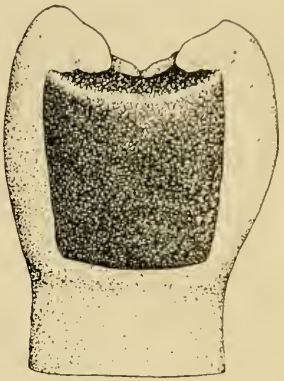


FIG. 202.—The two portions united and the filling completed.

7. Build the rest of the filling to proper restoration of **contact and occlusion form,** leaving an excess of gold over the cavo-surface angle, and the balance of the surface to allow for finishing (Fig. 202).

8. **After Condensation.**—Go over the entire filling with a small **foot plugger,** and thoroughly condense.

Ten Rules for Plugging Cohesive Gold

1. **Pluggers.**—Use pluggers ranging from 1/2 to 1 millimeter in size, 1/2 millimeter for starting in convenience angles, and larger sizes up to 1 millimeter for building.

2. **Stepping.**—Step the plugger in definite lines, moving it only a distance of the diameter of its face, after each thrust or blow, to avoid *bridging* and imperfect condensation

3. **Condensing.**—Pack the gold in small pieces and thin layers, condensing each layer thoroughly by the *stepping process*, to assure thorough condensation.

4. **Direction.**—Pack in the general direction of the long axis of the tooth, wherever possible, in order to avoid lateral

strain on the pericementum and to place the layers of gold in a plane with the plane of the forces of occlusion, so that the crushing stress may be resisted to the utmost (Fig. 203).

5. **Angle of Force.**—Incline the shaft of the plugger about 6 centigrades from the lateral walls of the cavity, and pack from the center toward the walls.

6. **Contour.**—In proximal cavities build each layer out to full contour, to avoid the necessity of "pasting" gold on afterward, with resultant weakening of the surface of the filling.

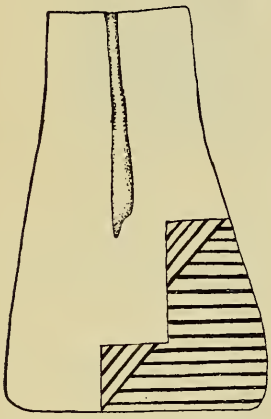


Fig. 203.—Showing the gold built in thin laminæ and placed in a direction to best resist the force of occlusion.

7. **Lingual Wall.**—In proximal cavities in anterior teeth, build the lingual portion in advance, finishing on the labial side, and see that the lingual margin is thoroughly covered, as each layer is adapted (see Figs. 194 and 195).

8. **Margins.**—Do not allow the plugger to come in contact with the margins, on account of danger of fracture of the enamel, but interpose a layer of gold before the blow is struck.

9. **Annealer.**—Use a gold annealer, with the flame adjusted to give sufficient heat.

10. **Wedging.**—In packing toward the lateral walls, wedge the gold in between the wall approached and the layer being condensed, in order that the filling may be gripped by the natural resilience or elasticity of the dentin.

Technical Exercises

Fill several of the prepared cavities on the technic form, or in the extracted teeth, with cohesive foil.

Advantages of Non-Cohesive Gold.

1. Insolubility.
2. Adaptability to cavity walls.
3. Ease and rapidity of introduction.
4. Capability of polish.

Disadvantages.

1. Color.
2. Non-weldability and consequent lack of crushing resistance, with the result that it is not indicated on surfaces exposed to mastication and cannot be contoured.
3. High conductivity.

For the method of preparation and working of non-cohesive gold, the reader is referred to the description of tin (see page 145), these two materials being worked after the same method.

METHOD OF POLISHING FILLINGS

1. **Fillings in Pit and Fissure and Gingival Third Cavities.** —(a) **Remove the excess** with Black's or Pichler's trimming knives, "flexo" or Black's files, carborundum stones, Gem points or sand and emery disks, depending on the size, location and shape of the filling. The general direction of the cutting should be *toward the margins*. Do not use rough stones as the outline of the cavo-surface angle is approached, for fear of damaging the margins; changing to knives, fine files, Gem stones or disks for this purpose. Trim or grind the filling down until the original shape of the tooth is restored, the operation on occlusal surfaces frequently requiring the application of much esthetic taste as well as mechanical skill to carve grooves and cusps to their original anatomical form. (b) **Polish,** first with garnet and then with cuttle-fish disks, in locations where these will readily reach, finally going over

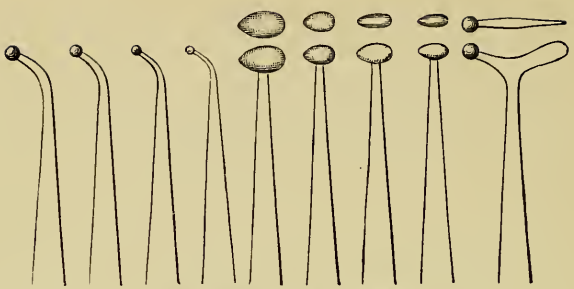


Fig. 204.—Gold burnishers.

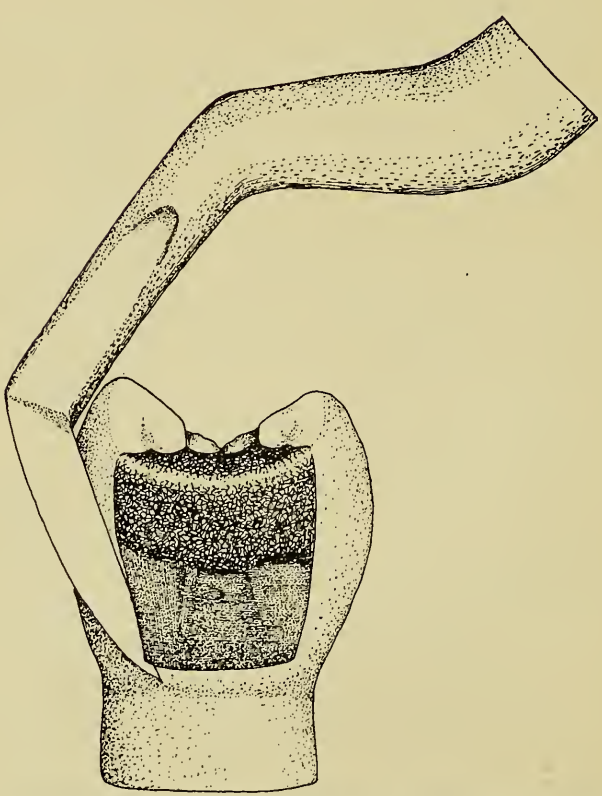


Fig. 205.—Removing the excess at the gingival portion with a Black knife.

the surface, if a specially high finish is desired, with crocus disks, or with chamois, felt, or moose-hide buffers, dipped in whiting or rouge. In pits and fissures, where the disk is not applicable, after the final shaping of the filling, the surface may be gone over with finishing burs, which will give a high burnish; or, if preferred, the use of wood points and wet pumice may be resorted to, finally going over the surface again with the chamois, felt or moose-hide wheels carrying whiting or rouge.

2. **Fillings in Proximal Cavities.** (a) **The Gingival Portion.**—After thorough burnishing (Fig. 204), the excess at the

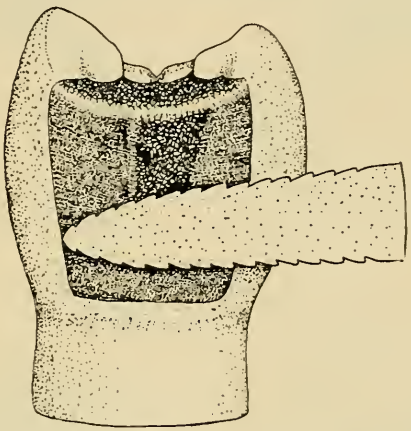


FIG. 206.—Application of the file to the gingival portion.

gingival portion, up to a point slightly gingival to the contact point, is first removed by means of a saw in a Wilson or Kaeber saw frame, or by the use of keen Pichler or Black knives. This portion is then gone over with the Black files, or the Rhein approximal trimmers until the filling is flush with the gingival margin (Figs. 205 and 206).

(b) **The Buccal or Labial and Lingual** portions then receive attention, the excess being removed by the use of the knives,

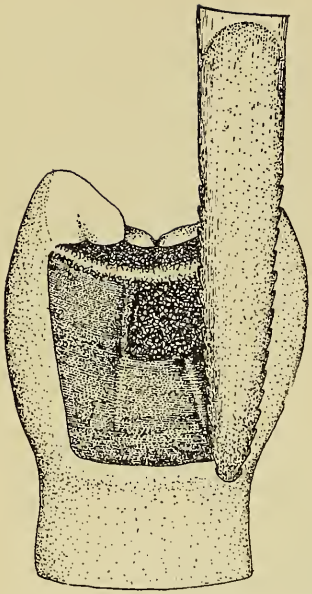


FIG. 207.—Filing the buccal and lingual portions.

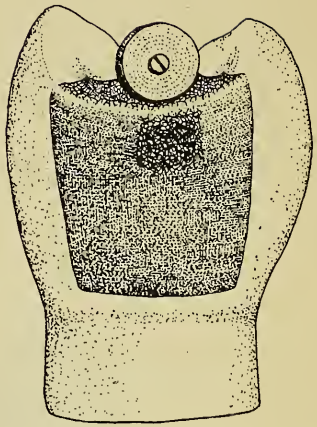


FIG. 208.—Use of the stone on the occlusal portion.

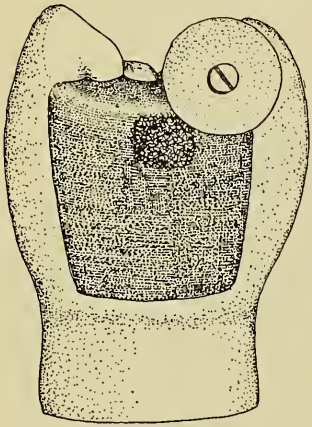


FIG. 209.—Polishing with the disk.

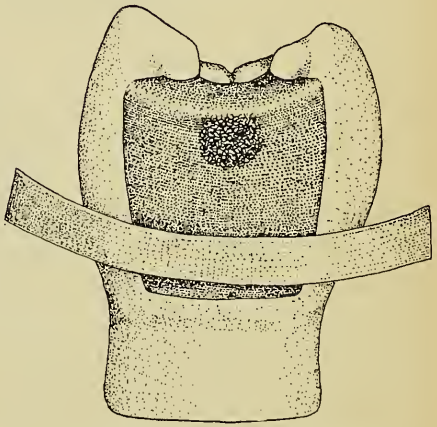


FIG. 210.—Application of the polishing strip to the inter-proximal portion.

the files, or, where convenient, small stones, finishing burs, sand and emery disks (Fig. 207).

(c) **The Occlusal or Incisal portions** next receive attention in the same manner, leaving the contact point untouched. (Fig. 208).

(d) **The entire filling** is then gone over again, with the exception of the contact point, with the finer polishing strips and disks, using the disks only on the labial, buccal, lingual,

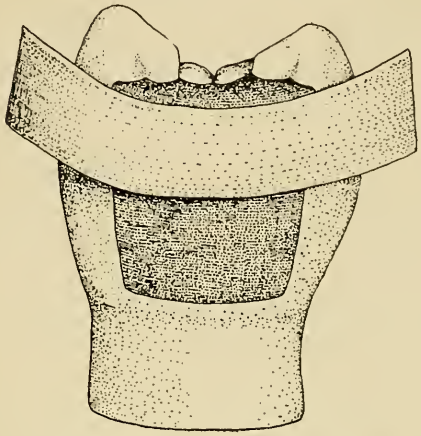


FIG. 211.—Polishing the contact point.

incisal or occlusal margins, utilizing the strips for the shaping of the inter-proximal portion (Figs. 209, 210).

(e) **The contact point** should now remain as a small marble contact, as nature intended it, and is now gone over (being careful not to flatten it) with a fine linen polishing strip, making increased separation, if necessary, for this purpose. (Fig. 211).

(f) **In case a still higher finish is desired,** the exposed surfaces are now gone over with whiting or rouge on the buffers.

CHAPTER V

THE TREATMENT OF PULPS AND THE OPENING AND FILLING OF PULP CHAMBERS AND CANALS

General Considerations.—The pulp is situated in the pulp chamber and canals, which it completely fills. It sends out numerous prolongations, the **dentinal fibrillæ,** which penetrate the dentin to the **dento-enamel junction,** and in some cases enter the enamel. The enamel is a low conductor and acts as a **protective covering** to the pulp and the dentinal fibrillæ, preventing the contact with and the transmission of sensations of heat and cold, electricity, and chemical substances. When the enamel is intact and the pulp healthy, the tooth is **not sensitive** to ordinary variations in temperature, the application of a mild electric current, or the presence of the chemical substances usually found in the mouth, such as sweets and acids. If, however, through the action of decay or other causes, the enamel be lost and the dentinal fibrillæ be subjected to the action of these agents, they soon become **abnormally responsive** to them, transmitting these sensations to the pulp, which soon becomes irritated, and a **diseased condition** of its substance supervenes.

1. **If the condition receive early treatment,** the resultant fulness in the arteries of the pulp (**Arterial Hyperæmia**) be relieved and the lost enamel and dentin be compensated for, by the application of a non-conducting filling, *the pulp may be permanently restored to its normal condition.*

2. **If allowed to continue,** the increased supply of blood in the arterial system of the pulp is dammed back into the veins (**Venous Hyperæmia**) and this condition supervening, finally

results, on account of the pressure produced in the vessels, in the passage of a portion of the blood into the interstices of the pulp tissue, with the result that a condition of **Inflammation** is established. When Venous Hyperæmia or Inflammation is present, *the only alternative is the destruction and removal of the pulp.*

3. **If the condition be still further neglected,** germs, constantly present in the mouth, make their entrance into the pulp tissue, with the result that pus formation occurs (**Suppuration**), or the death of the pulp is finally accomplished through a process of putrefaction, with the formation of malodorous gases (**Putrefactive Decomposition** or **Moist Gangrene**). If, however, germs do not enter, the pulp will die a natural death from lack of nourishment (its blood supply being interfered with) and the condition of **Dry Gangrene** is established.

4. **If these latter conditions supervene,** there is then always the possibility of the pathological condition extending through the apical foramen, with the resultant production of disease processes in the tissues of the apical space, and the formation of an **Alveolar Abscess.**

The diseases of the pulp mentioned above are **progressive** in character and may be briefly described as follows:

1. **Arterial Hyperæmia.**—An increased supply of blood in the arteries of the pulp, resulting in over-fullness and distention of these vessels, with consequent pressure on the nerves and resultant pain.

2. **Venous Hyperæmia.**—The blood is dammed back into the veins, with the production of the same conditions in these vessels and increased pain from pressure.

3. **Inflammation.**—The pressure in veins and arteries results in the passage of the blood plasma and corpuscles through their walls into the interstices of the pulp tissue.

4. **Suppuration.**—The corpuscles and the surrounding pulp tissue are broken down and transformed into pus, through the action of germs, which have entered by way of the blood stream.

5. **Moist Gangrene.**—(Putrefaction.) The blood current becomes stagnant and finally ceases, on account of the pressure in the vessels passing through the minute apical foramen. Death of the tissues occurs from lack of nourishment, putrefactive decomposition and destruction occurring through the action of germs, with the formation of malodorous substances.

6. **Dry Gangrene.**—Germs do not enter, death of the tissues occurring without suppuration or putrefaction, from strangulation and lack of nourishment.

7. **Alveolar Abscess.**—The putrescent material infects the tissues of the apical space, with resultant pus formation, breaking down and destruction of these parts.

The above conditions may be **classified** as follows, viz.:

1. **Vital Pulps.**

(A) Pulps capable of being restored to the normal (Arterial Hyperæmia).

(B) Pulps incapable of being restored to the normal. { (Venous Hyperæmia) (Inflammation) (Suppuration)

2. **De-Vital Pulps.**

(A) Pulps uninfected. (Dry Gangrene.)

(B) Pulps in a state of putrefaction and infection. (Moist Gangrene.)

(C) Pulps with apical complications. (Alveolar Abscess.)

Avoidance of Pressure.—In cases of **exposure** (a minute opening through the wall of the pulp-chamber), the vital pulp rebels against the application at the point of exposure of the slightest amount of pressure, so that during the treatment of

these conditions, great **delicacy of touch** and the absolute avoidance of pressure is essential.

Adoption of Aseptic Precautions.—Owing to the fact that the saliva and the decay present in cavities is highly infected with **germs,** whenever an exposure of the pulp occurs, these germs enter the pulp chamber and infect the pulp tissue, producing what is known as a **Septic condition.** The pulp is infected, then, in all cases of pulp exposure, and there is also a possibility of these germs entering to the pulp through thin layers of dentin in the floor of cavities, by way of the dentinal tubules, even in those cases in which the pulp is not exposed. In the conditions of Suppuration and Moist Gangrene, highly infective micro-organisms are always present. This being the case, it becomes necessary in treating these conditions in the mouth to adopt measures to prevent, as far as possible, the entrance of these germs by absolutely and permanently **excluding the saliva** from the cavity; or, in case the germs are already present, to destroy them by the application of certain drugs known as **Antiseptics** and **Germicides,** which will either inhibit their further growth or totally destroy them. These measures are known as **Aseptic Precautions,** because they prevent or relieve the septic condition, and consist of the *application of the rubber dam in all cases* (Fig. 212, also see Figs. 115 and 116), and the *use of antiseptics* on the tissues being operated upon, as well as on the instruments used.

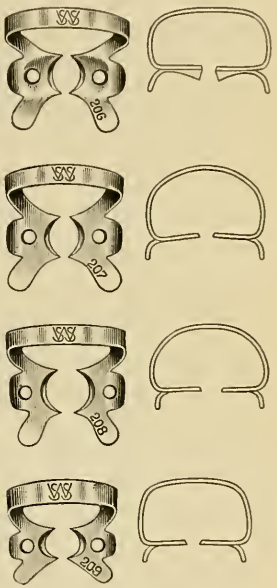


FIG. 212.—Bicuspid rubber dam clamps.

(1) TREATMENT OF VITAL PULPS

(A) **Pulps Capable of being Restored to the Normal.**—The treatment is known as **Conservative** treatment, and depends on whether the decay, when present, has extended to the pulp chamber, constituting the condition known as **Exposure of the Pulp,** or whether it has not produced this condition. If the pulp be not exposed, the treatment applied is known as **Pulp Protection;** if the pulp be exposed, the operation of **Pulp Capping** may be resorted to.

1. **Pulp Protection.**—(a) Under "aseptic precautions," establish the outline form of the cavity, remove the decay, make slight retentive form, and seal into the cavity with base plate gutta percha or cement, a small pledget of cotton moistened with an **antiseptic** and **anodyne** (pain reliever), such as eugenol or oil of cloves. (b) At the end of 24 or 48 hours, if pain is relieved, remove the dressing under "aseptic precautions," place a cement intermediate in position and fill.

2. **Pulp Capping.**—(a) Repeat the procedure as in "(a)" under Pulp Protection. (b) Remove the dressing at the end of 24 or 48 hours under aseptic precautions. (c) Swage on a soft block of wood by means of a round-end burnisher, a thin concavo-convex, German silver disk, of the size and shape to cover the orifice of the exposure. (d) Fill the *concave* side of the disk with a thin paste of zinc oxid and oil of cloves, and gently place the cap, with the concave side down, over the exposure, by means of a small pair of dressing pliers. *Avoid pressure.* (e) Cover the cap with a thin mix of cement, avoiding pressure, and complete the filling with cement mixed to a thicker consistency.

(B) **Pulps Incapable of Restoration to the Normal.**—The treatment is known as **Radical** treatment, and consists in the adoption of one or the other of the following procedures, *viz.*,

(1) Devitalization.
(2) Anesthetization.

(1) **Devitalization.**

Technic.—(a) Under aseptic precautions establish the outline form, remove the decay and make the cavity slightly retentive, avoiding pressure on the pulp. (b) **If the pulp is aching,** place gently over the exposure a pledget of cotton saturated with an **anodyne,** such as eugenol or clove oil, and seal (avoiding pressure) with base plate gutta percha or cement, allowing it to remain for from 24 to 48 hours. (c) Remove the dressing under aseptic precautions, and gently place directly over the exposure, or slightly to one side, with a pair of dressing pliers, a small pledget of cotton or piece of asbestos, on which has been placed a minute amount of **arsenical paste.** (d) Seal, avoiding pressure, with gutta percha or cement, and allow to remain from one to seven days (usually two days), at the end of which time the vitality of the pulp is destroyed, and it may be painlessly removed.

Arsenical Paste is a mixture of arsenic trioxid with cocaine hydrochlorid and other drugs for the relief of pain. The arsenic trioxid gradually produces death of the pulp through a **process of inflammation,** finally causing **strangulation** of the vessels by cutting off the blood supply at the apical foramen. Its action is usually painful, hence its combination with cocaine and other pain-alleviating drugs. If the minutest amount of **arsenic trioxid escapes** from the cavity and comes in contact with the gums, it will produce inflammation and death of these parts (**arsenical poisoning**), which is liable to extend to the bony tissues, hence great care must be observed in placing arsenical dressings to see that they are **perfectly sealed.**

(2) **Anesthetization.** (Pressure anesthesia.)

Cocaine has the property of temporarily depriving the

tissues of sensation. When forced into the tissues of the pulp, that organ is for a time **anesthetized,** when it may be painlessly removed.

Technic.—(a) and (b) Perform the same procedures as described under the same headings for "devitalization." (c) Place a small piece of cocaine hydrochlorid in the bottom of the cavity, and after adding a drop of sterile water, when it will be dissolved, cover it with a pledget of cotton. (d) Cut a piece of soft, unvulcanized rubber of a size sufficient to fill the cavity, and with a large amalgam plugger or smooth burnisher, slowly and gradually **apply pressure,** thus forcing the cocaine solution into the pulp, constantly maintaining pressure until it does not elicit pain, when the rubber and cotton are removed and the pulp is ready for **extirpation** (removal). The rubber is placed so that it acts as a washer and prevents the backward flow of the cocaine solution.

(2) TREATMENT OF DE-VITAL PULPS

(A) **Pulps Uninfected (Dry Gangrene).**—The pulp has not been exposed to external influences, hence is not infected and simply remains in the sound, undecayed tooth, or under an old filling, in a **dry, shrivelled condition.** The treatment consists in its removal under aseptic precautions, with immediate root filling, or the sealing in the canals for two or three days, of cotton containing a bland **antiseptic,** such as phenol or 5 per cent. solution of formalin, after which they are ready for filling.

(B) **Pulps in a State of Putrefaction** (Moist Gangrene). —A large number of **germs** are present, the pulp tissue is rapidly being transformed into a putrefying mass and gases of a disagreeable odor are being formed, through the process of **putrefactive decomposition,** all of this constituting a highly

septic condition. The treatment consists in the application, under aseptic precautions, of agents which will destroy the germs (**antiseptics and germicides**), and chemically transform the putrefactive material and gases into *harmless substances*.

Technic.—(a) Under aseptic precautions, establish the outline form, remove the decay, and make the cavity retentive. (b) Open the pulp chamber and remove the **bulbous** portion of the pulp. (c) Seal in the pulp chamber, by means of base plate gutta percha or cement, on a pledget of cotton, a mixture of equal parts of formalin and cresol, known as **formo-cresol.** (d) At the end of from 24 to 72 hours, take out the dressing under aseptic precautions, and remove the remainder of the pulp **from the canals.** (e) Place *in each canal*, and also in the pulp chamber, cotton containing the formo-cresol mixture, and seal the cavity as before. (f) After an interval of from 24 to 72 hours, remove the dressings under aseptic precautions and fill.

(C) **Pulps with Apical Complications (Alveolar Abscess.)**—The putrefying material and the germs have been forced by the expansion of the gases being formed, through the apical foramen into the tissues of the **apical space.** The treatment, in addition to that outlined above, consists in the application of measures to relieve the conditions at the end of the root, and will not be considered here.

Technical Exercises

1. Surround the apices of the roots of the teeth on which the pulp treatments and the exercises in canal work are to be performed with wax, to simulate the tissues of the apical space. Mount the teeth in plaster of Paris, molding and carving it to a convenient size and shape for handling.

2. Establish the outline form of the cavities, remove the

decay and render slightly retentive, exposing the pulps, if not already exposed.

3. Seal antiseptic and anodyne treatments in several teeth.

4. Perform the operation of pulp capping on several teeth.

5. Perform the operations of arsenical devitalization and pressure anesthesia on others.

OPENING PULP CHAMBERS AND CANALS

One or the other of the following conditions will be present.

1. The pulp has been previously **anesthetized** with cocaine, or **devitalized** with arsenic.

2. The pulp is devital and uninfected; or in a state of **putrescence** and infected with germs.

Rule 1.—When cavities are present, make the approach to the pulp chamber through the cavity.

Rule 2.—In sound teeth, or teeth with perfect fillings, enter through the center of the lingual surface of incisors and cuspids, the mesial pit of bicuspids and the central fossa of molars.

Rule 3.—Enlarge the opening, whether through an already existing cavity or one artificially made, until **convenient access** to the pulp chamber and canals is obtained; at the same time, *avoid weakening the tooth* by too much cutting.

Rule 4.—Make the **walls of the cavity and pulp chamber** *continuous* and *smooth*, though not necessarily parallel or on the same plane.

Rule 5.—Make the **walls of the pulp chamber and canals** continuous and smooth.

Technic for Opening into Pulp Chambers

1. **In Sound Teeth.**

(a) **Perforate the enamel** with a 1-millimeter bi-bevelled

dentate fissure bur (made by bevelling a dentate fissure bur on two sides), or a small spear-point drill, in the handpiece of the engine.

(b) **Enlarge the opening** with a larger sized bur or drill.

(c) **Perforate the dentin** gradually to the pulp chamber, alternating first with the smaller and then the larger sized burs or drills, avoiding the **danger of breakage** by frequently withdrawing, and continuing in this manner until the pulp chamber is reached.

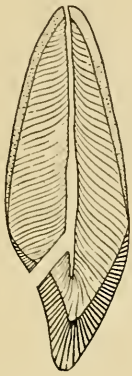


FIG. 213.

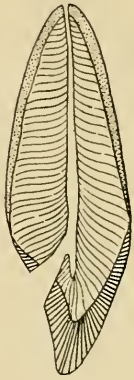


FIG. 214.

FIG. 213.—Series of illustrations showing the method of opening into the pulp chamber and canal through the lingual surface of the anterior teeth.

First drill through the enamel and dentin until the pulp chamber is reached; then gradually enlarge the opening with burs or drills of increasing diameter.

FIG. 214.—Then increase the size of the entrance by inclining the shaft of the fissure bur first toward the gingival and then toward the incisal portions.

(d) **Enlarge the opening** with the same instruments until convenient access is obtained, and then remove the entire wall of the pulp chamber, extending the cuttings out until the **horns** of the pulp chamber are included.

(e) Make the walls of the cavity and pulp chamber **continuous and smooth.**

(f) Remove the **contents of the pulp chamber** and all débris (Figs. 213, 214, 215 and 216).

2. **Through Cavities of Decay.**

(a) Establish the outline form, remove all decay, and make the cavity slightly retentive.

(b) If the pulp is not exposed, penetrate the dentin to the pulp chamber, with the drills or the bi-bevelled dentate fissure bur.

(c) **Remove the wall of the pulp chamber** with a hoe

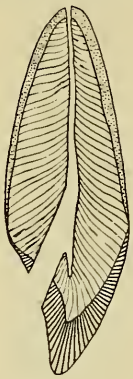


FIG. 215.

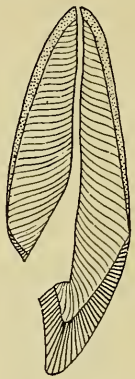


FIG. 216.

FIG. 215.—Straighten the approach to the canal on the lingual side by means of the fissure bur. The passage of a small broach to the apex has thus been rendered easy by the removal of the small shoulder at the entrance to the same shown in the preceding illustration.

FIG. 216.—Place the dentate fissure bur in position and open the chamber to its incisal extremity, thus removing the horns of the pulp chamber with their contents. The walls of the cavity, pulp chamber and canal are now continuous and smooth.

excavator or a dentate fissure bur, extending the cuttings until the *horns of the chamber are included.*

(d) In incisors and cuspids **straighten the approach** to the canal by extending the cavity in the lingual or gingival direction with a dentate fissure bur.

(e) In upper molars, **straighten the approach** to the mesio-buccal canal by extending the cavity with a fissure bur toward the mesio-buccal cusp, and enlarging the pulp chamber in the same direction by means of the same instrument or a cleoid excavator.

(f) Make the walls of the **cavity and pulp chamber** continuous and smooth.

(g) Remove all debris.

Technic for Opening into Canals

The **anterior teeth,** both upper and lower, have one root canal which is continuous with the pulp chambers, and as a rule easily found after the approach has been straightened, as already described. The **upper first bicuspids** have, in the majority of instances, two canals, one buccal and one lingual, although in probably one-third of the cases, only one canal is present. The **upper second** and the **lower bicuspids** present as a rule a single canal. In the **upper molars** there are present three canals, a mesio-buccal, disto-buccal, and lingual, placed at the *angles of a triangle* (molar triangle). The **lower molars** have a mesio-buccal and a mesio-lingual canal, located in the mesial root and a distal canal situated in the distal root. The canals in the lower bicuspids are more or less continuous with the pulp chambers, while those in the upper bicuspids and the upper and lower molars are separate and distinct from the chamber, opening from its floor with more or less **constricted orifices.** Owing to the presence of these constrictions, and the small size of the buccal canals in the upper molars and the mesial canals in the lowers, difficulty is frequently experienced in locating their entrances and following them with instruments to their termination.

Technic.—(a) **Locate** the entrance and **explore** the canals with a small, round, smooth broach.

(b) **Enlarge the orifice** with a Kerr or Downie tapered canal reamer, a small bud-shaped bur, a twist broach, spiral broach reamer, or a Donaldson canal cleanser (Figs. 217 and 218).

(c) Make the walls of the pulp chamber and canals **continuous.**

(d) **Pass a small canal cleaner** to the apex, or until it binds, withdraw slightly, give it a half turn and then remove from the canal, bringing away as much of the pulp tissue as possible. Continue thus, using larger and larger sizes, as the canal will permit, broaching or **rasping** the sides of the canals, and gradually enlarging them. **Carry the broach just to the**

FIG. 217.

FIG. 218.

FIG. 217.—Cavity of decay on the mesial surface of a central incisor opening into the pulp chamber. It would be difficult to pass a broach to the apex owing to the shoulders on the mesial side of the entrance to the canal.

FIG. 218.—Straighten the approach to the canal by enlarging its entrance on the mesial side with a dentate fissure bur, a Kerr tapered canal reamer or a spiral broach reamer. Then enlarge the cavity toward the incisal and remove the horns of the pulp chamber. The cavity, chamber and canal are now continuous and smooth.

apex, and no further. The passage of the broach through the apical foramen will produce irritation in the tissues of the apical space, and consequently should be avoided.

(e) **Small Canals.**—In small canals, where entrance with a barbed canal cleanser is difficult, change to a spiral broach reamer, or a **twist broach.** Start with the smallest size, carefully boring in and withdrawing in a direction which will tend to straighten the canal, gradually changing to larger and

larger sizes, until the canal is thoroughly opened (Figs. 219 and 220).

(f) **In difficult cases** a 50 per cent. solution of sulphuric acid, or better, phenol-sulphonic acid (which latter more readily clings to the broach), carried into the canal on the broach, will, by uniting chemically with the calcium salts of the dentin, soften the walls of the canals and render the work easier. Its action should be *neutralized* on completion of the operation with a saturated solution of sodium bicarbonate.

(g) Remove all debris.

(h) After the proper medicinal treatment has been given, depending on the conditions

FIG. 219.—Reaming the canal with a Kerr twist broach.

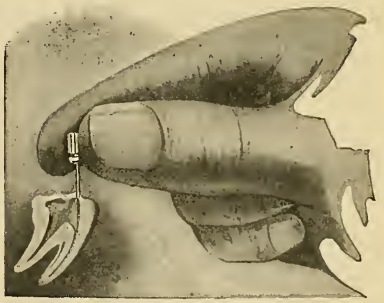


FIG. 220.—Enlarging the canals of a lower molar with a Nub broach.

present, as already described, the canals are ready for drying and filling.

Wrapping Cotton on Smooth Broaches.—The method varies, depending on whether the cotton, containing some medicament, is to be temporarily left in the canal, or whether

it is to be immediately withdrawn on the broach, as in swabbing or drying the canal.

1. **When the Cotton is to be left in the Canal.**—(a) Place a few wisps of cotton on the pulp of the forefinger of the left hand. (b) Lay a round or square smooth broach on the cotton, allowing the end of the cotton to extend slightly beyond the point of the broach. (c) Rotate the broach to the *right* with the thumb and fingers of the right hand, at the same time rolling the cotton in the same direction with the thumb and forefinger of the left hand. Roll the cotton fairly tightly at the point of the broach and loosely the rest of the way. (d) Fold the slight excess of cotton left at the end of the broach over that already rolled and roll it in the same direction as before, so as to thoroughly cover the point of the broach. (e) Carry the broach containing the cotton as far as possible into the canal to be treated. (f) Rotate a turn to the *left*, at the same time withdrawing it a short distance, when the cotton will be disengaged. (g) Pack the cotton further into the canal by pushing the broach slightly forward, and then, again rotating to the *left*, withdraw a short distance, continuing in this manner until the broach is entirely free of the canal and the cotton remains in position.

2. **When the Cotton is to be Withdrawn on the Broach.**—(a) File off the sharp point of the broach or nick it off with a pair of scissors, leaving it slightly roughened, so that the cotton will be held more securely. (b) Wrap the broach with the cotton as already described, except that it should be wrapped *tightly* throughout the procedure. (c) Carry the broach into the canal and on withdrawal, rotate to the *right*, when the cotton will remain on the instrument. (d) To remove the cotton from the broach grasp it firmly between the thumb and forefinger of the left hand and twist the broach to the *left* with the right hand.

FILLING CANALS

It is necessary that the canals to be filled have been **thoroughly treated** under aseptic precautions, the saliva excluded throughout the course of treatments, all debris and remaining decomposable material removed, and **absolute dryness** accomplished.

Drying Canals.—Wrap a few shreds of cotton on a smooth broach and swab out the canal, absorbing all moisture possible by changing the cotton on the broach as often as necessary to accomplish the result. Then force in a current of **hot air** from the heated bulb of the chip blower, or some of the various forms of root canal driers, until absolute dryness is accomplished, when the canals are ready to fill.

Requisites of a Good Canal-filling Material.—It should be

1. Non-irritant to the tissues of the apical space.
2. Indestructible in the fluids entering at the apex, or through the pulp chamber (in case of leaky fillings).
3. Easy of introduction.
4. Antiseptic in character.
5. Colorless.
6. Easy of removal (in case of trouble arising later).

Rule.—Endeavor *always* (a) to completely seal the apical foramen, (b) avoid forcing the material through, and (c) to so adapt the material to the walls of the canal that all air will be excluded and the canal for its entire length be hermetically sealed. This is not always possible, owing to the varying size, tortuosity and inaccessibility of canals, but if the ideal stated in the above rule be constantly aimed at, the operator will at least have the satisfaction of a clear conscience.

Technic.

Two methods will be described, one for large and one for small canals.

1. FILLING LARGE CANALS.—Gutta-percha points.

(a) **Measure the diameter of the apical foramen.** Pass a small, smooth broach, or canal plugger, to the apex. If it passes through, change to a size larger, or two sizes larger, continuing until one is found which will pass just short of the apical foramen.

(b) **Measure the length of the canal.** Pass a small, smooth broach, or a hooked extractor, if the size of the canal will permit, to the apical foramen, catching the hook over the apex, if the latter instrument is used. A small piece of cardboard or rubber dam encircling the shaft of the broach is moved until it is in contact with the crown of the tooth, when, the broach being withdrawn, a measurement of the length of the tooth is seen, and a guide as to the length of the canal is obtained (Fig. 221).

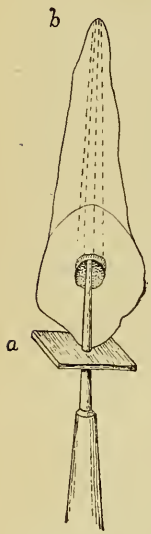


FIG. 221.—Measuring the length of the canal.

(c) **Select a tapering Gutta-percha cone** (Fig. 222), approximating the size of the canal, and cut off its end, until it is the size of the apex as previously determined.

(d) **Cut off a section** about 3 or 4 millimeters in length, which will be utilized for filling the apical portion. Also cut the rest of the cone into small sections for filling the balance of the canal.

(e) **Wrap a smooth broach** with a few shreds of cotton, dip it in eucalyptol and freely moisten the canal. Avoid too much cotton on account of the tendency to form a piston and force the solution through the apex. Remove all excess of eucalyptol with a broach wrapped with dry cotton, *leaving the wall slightly moistened with eucalyptol.*

(f) **Catch up the smallest section** of a Gutta-percha cone on the end of a warmed root canal filler, dip it in eucalyptol,

remove the excess, carefully carry it to place and tamp to position, withdrawing the plugger, when the apical portion is filled.

(g) **Continue the procedure** with the next largest pieces in order, carefully packing to position, and **warming** the largest pieces, until the canal is filled; then **seal** the pulpal opening with a warm plugger or burnisher.

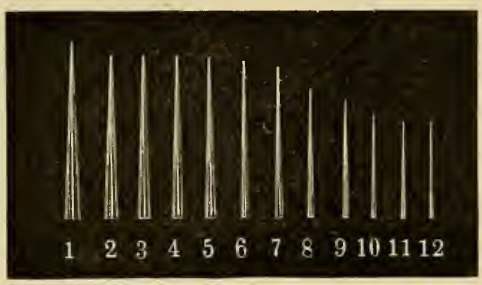


FIG. 222.—Gutta-percha canal points.

(h) **Fill the pulp chamber** with Oxyphosphate of Zinc Cement.

2. FILLING SMALL CANALS.—(Gutta-percha and Chloro-percha).

(a) **Moisten the canal with eucalyptol** as before.

(b) **Dip a small, smooth broach,** on which are wound a few fibers of cotton, into chloro-percha and pump the canal as full as possible, avoiding forcing the material through the apex.

(c) **Force in on a smooth broach,** squared on the end, a small section of a gutta percha cone, as large as the canal will accommodate, and *seal the entrance* to the canal with a warm canal plugger or burnisher.

Making Gutta-percha Points.—These may be obtained ready prepared. An excellent method of making them in the laboratory of various sizes and shapes is as follows: Warm a

clean, smooth cement slab. Cut off a small section of **Gutta-percha base-plate,** and after heating it over the alcohol lamp, roll into a cone between the clean thumb and forefinger. Lay it on the warm slab, and with a warmed, broad, clean cement spatula, roll it out quickly into a long rope. As the rope gets longer and longer it will be convenient to hold one end by pressing it on the slab while using the spatula in the other hand, and working it with a back and forth movement. The roll, as it approaches the proper size, may be cut into sections, and then each section may be rolled separately into any size desired. They may then be cut into convenient lengths, with the hot spatula or a knife.

Technical Exercises

1. Open the pulp chambers and canals of the teeth prepared under Pulp Treatments, the presence of the wax covering the apices of the roots serving as a guide to prevent the passage of the canal instruments too far.

2. Seal in the pulp chamber and canals several cotton dressings containing anodyne, antiseptic and formo-cresol treatments.

3. Remove the dressings, dry and fill the canals after the two methods described.

CHAPTER VI

SUGGESTIONS TO THE TEACHER

"He teaches who gives, and he learns who receives. There is no teaching until the pupil is brought into the same state or principle in which you are; a transfusion takes place; he is you, and you are he; then is a teaching, and by no unfriendly chance or bad company can he ever lose the benefit."—Emerson.

The first requisite to successful teaching of the subjects of Dental Anatomy and Operative Technics is enthusiasm for the work on the part of the teacher, and the second is the ability to instill this enthusiasm into each individual member of the class. The teaching of the subject is an art, as is the teaching of any other subject, which is only acquired by intelligent observation and close study. The idea that teachers are born and not made is, to a large degree, an erroneous one. A great man, when asked to define genius, replied to the effect that it was one part natural aptitude and nine parts hard work in a given field of endeavor. The writer prefers to subscribe to this theory as applied to teaching.

It is an excellent plan to meet the class for the first time in an informal manner, endeavoring to learn the names of the students as early as possible, so that they may be called individually when speaking in the class room or laboratory. A few words of fatherly advice in regard to morality and purity of living, as well as the early acquirement of studious habits, will not be amiss and will impress the class with your personal interest in their welfare. A short talk on the importance of a knowledge of the subject of Dental Anatomy,

bringing out its bearing and relation to other branches of dentistry, as well as its practical application in all future work and a brief discussion of the noble and elevated character of the profession, its artistic and scientific nature, as well as its broad scope, will be of benefit.

The student should be given something to do at the first meeting (making drawings of some point mentioned or taking notes) and his interest not be allowed to lag for lack of employment, from this time throughout the course. As few set lectures as possible should be given, rather assigning a lesson for the next time of meeting, and using an informal quiz and explanation method. Do not talk *at* but *to* and *with* the student. He should bring his text-book to the class and many points which have not been fully brought out in the text may thus be elucidated. The book has been bound in a convenient size for carrying in the pocket.

Frequent written quizzes are valuable, the notebooks being turned in to the teacher for grading and correcting. Drawings and the notes, as well as the written quizzes, should be made in a book designed for the purpose. One of the many forms of loose-leaf notebook will serve the purpose admirably. The paper should be unruled and of such quality that the drawings may present a good appearance. The student should be given to understand that he will be graded on the care and condition of his notebook, thus stimulating a habit of neatness.

At stated times the oral quizzes may be transformed into a *bee*, after the fashion of the old *spelling bee*. The class is divided into halves and a number of students from each section are requested to come forward and arrange themselves on opposite sides to uphold the honor of their section in demonstrating their knowledge of the questions to be asked. The interest thus stimulated is frequently gratifying.

If the class is large, the teacher should keep a roll book of his own, even if other methods of taking the roll are in vogue in the school. The habit of calling the roll himself insures early assembling and enables him to more readily notice individual delinquency in promptness and attendance. A diagram of the seats in the classroom and of the work benches in the laboratory, with the students' names written in their proper places, is a valuable aid in tracing individual students in large classes, their attendance, quiz marks and other grades and necessary memoranda being kept opposite their names on the chart, instead of in an ordinary roll book.

If a student is late he should be quizzed before the period is over; if he is noticed talking or inattentive he should be quizzed; if he is absent he should be quizzed at the next succeeding period. If this plan is followed, there will soon be little trouble in regard to the above delinquencies, as the students will soon learn your method of dealing with cases of that kind.

All of the technic exercises should first be performed and explained by the teacher and then copied by the class, from conveniently displayed models, located about the room. The work should be so mapped out that the technic operations are being performed, as far as possible, while the talks and quizzes are being given on that subject and these should be, if possible, completed by the entire class before the consideration of another subject. An excellent method of dealing with those disposed to lag behind is to quiz them at every opportunity and to inspect their technic work frequently, inquiring into the cause for their backwardness. A little *encouragement*, though, will frequently accomplish much better results with these individuals than rough methods.

It is a good plan to have the technic work deposited in the teacher's room at the end of each period, the student's box

being numbered and kept in its own place. In this way his application and progress may be more closely watched.

An excellent plan in mapping out the course is to figure out the number of weeks and the number of hours in each week to be devoted to the work. In this way the teacher may readily note the progress the class is making and keep the work moving along to schedule time.

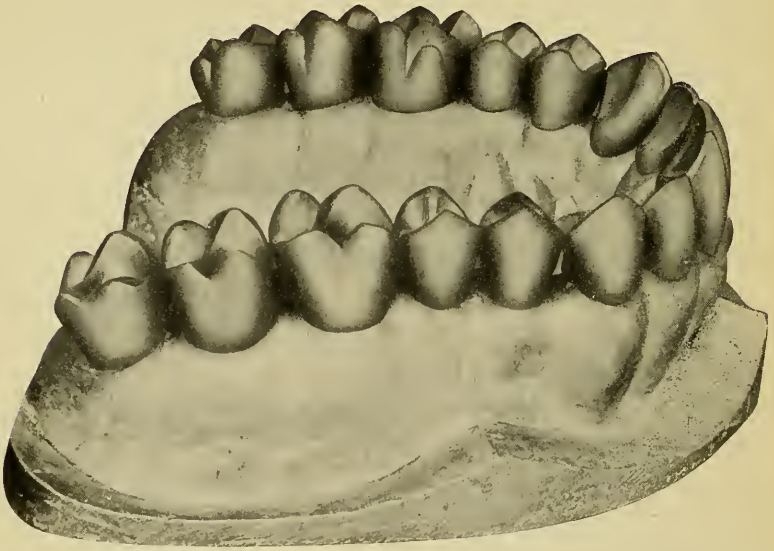


FIG. 223.—Enlarged aluminum model used by the author for teaching dental anatomy.

Enlarged models of natural tooth forms are valuable for teaching Dental Anatomy and these, with typical cavity preparations, and removable fillings, are of great service in the Operative Technic course. The plan of calling students from the class to point out certain points of interest on these enlarged forms works well. At Northwestern University Dental School is a set, carved in wood, many times enlarged, and mounted on a frame with rollers for easy handling. Typical

cavity forms have been prepared in these anatomically correct specimens and the wood fillings are made in sections, so that the various steps in the filling operation may be readily demonstrated.

Figures 223 and 224 illustrate a model designed by the author and made under his supervision by one of his former pupils, Dr. C. H. Chapman.

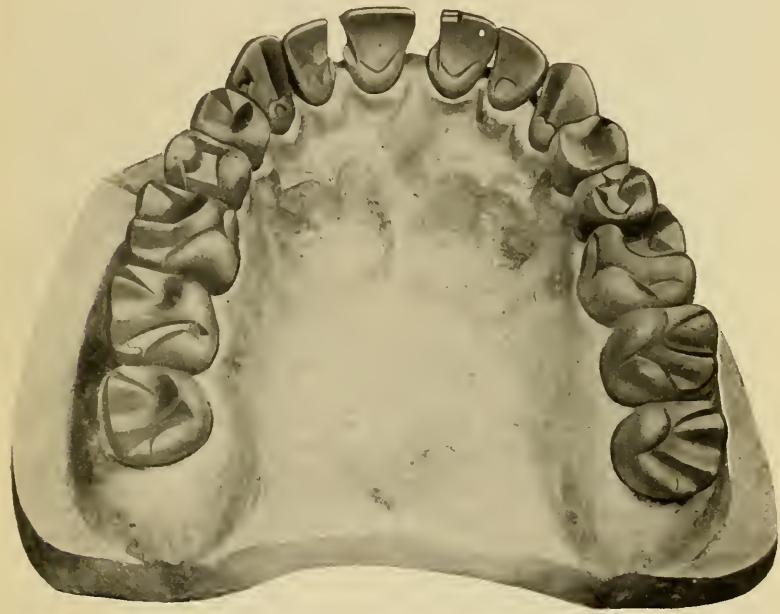


FIG. 224.—Same model as shown in Fig. 223 carrying teeth with typical cavity preparations.

This model is of aluminum with removable teeth. There is a complete set of perfect natural tooth forms, Black's average measurements, enlarged. There is also a set, which is interchangeable, with typical cavity forms, very useful for demonstrative and display purposes. Enlarged models are, in the writer's opinion, more useful for demonstrating pur-

poses than the lantern, though where these are not available, the lantern is a valuable adjunct.

At the University of Southern California, Dental Department, Los Angeles, there is in use an enlarged set of plaster models designed by Professor H. Gale Atwater, showing various stages of decay, on which actual operations are performed before the class, with a set of enlarged instruments (Figs. 225, 226, and 227). At the University of California Dental

FIG. 225.—Dr. H. Gale Atwater's model and instruments. Both are made to Black's measurements, 25 diameters. A model of the lower teeth, not shown, is also used. In the illustration, ideal cavity forms have been completed. Enlarged matrices may be seen to the right of the picture.

Department, San Francisco, there is in use an enlarged set showing the progressive stages of gold-building operations in colors, which should prove very valuable.

The collection of an adequate number of extracted teeth is really not such a difficult problem, if pursued in the right manner. The College catalogue should contain a clause in a *conspicuous place*, appealing to its alumni for extracted teeth. The prospective student should also be requested, by way of

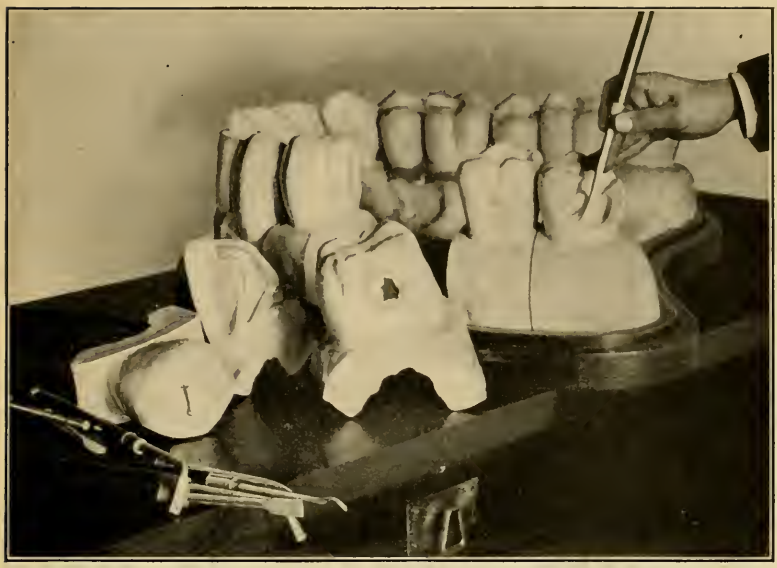


FIG. 226.—Another view of Dr. Atwater's model and instruments. Typical cavities of decay are seen, while the instrumentation incident to the preparation of a cavity on a molar will be noticed. The various pathological conditions incident to the formation of a cavity through the process of caries (such as partially affected dentin, the bacterial zone, leathery decay, brown caries, ptomaines and food debris) are imitated on these models.

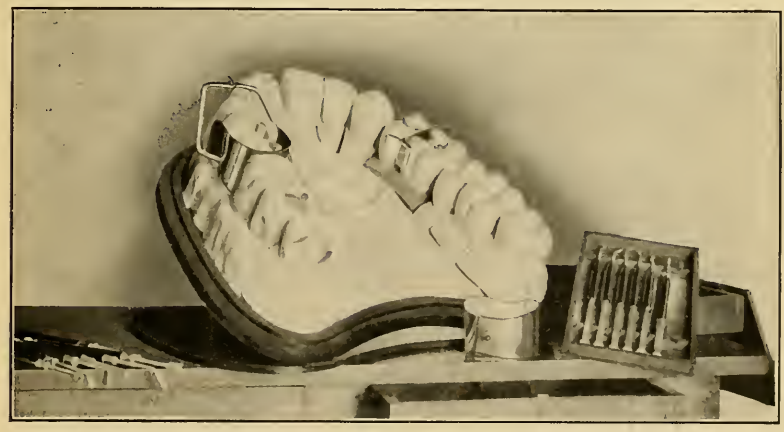


FIG. 227.—Another view of the model used in the University of Southern California, Dental Department.

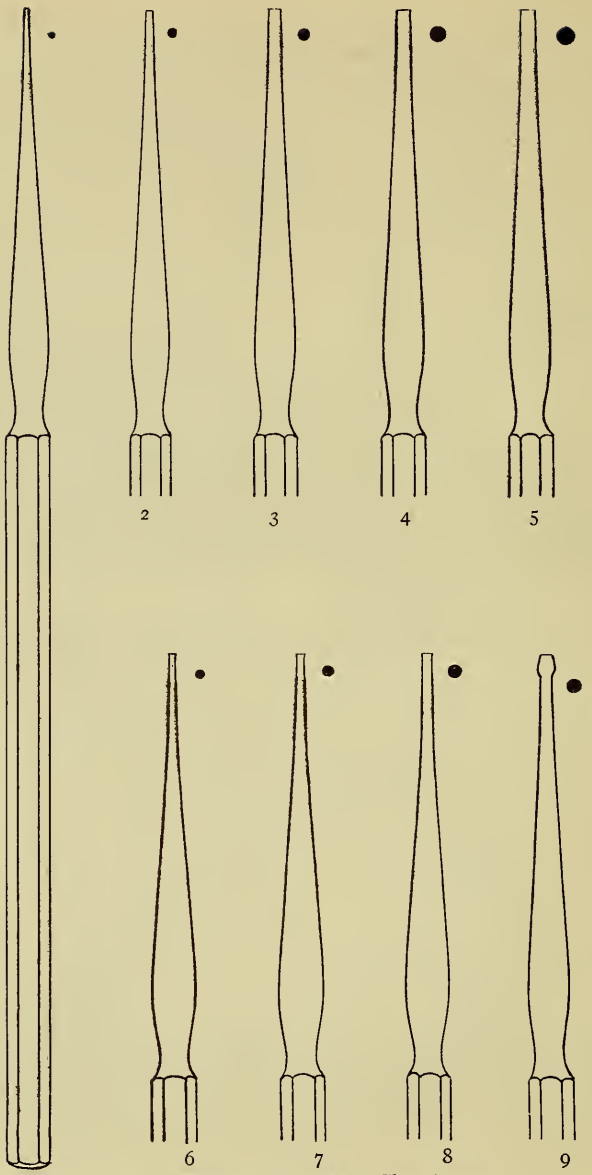


FIG. 228.—Excavator blanks. Clev. Dent.

the catalogue and otherwise, to bring extracted teeth with him. If the members of the class will take a bottle, labeled "Extracted Teeth" to any dentist of their acquaintance, this procedure will have the desired result in most instances, whereas, if the dentist is simply requested to save the teeth, he will in the majority of cases, forget, or neglect to do so. The labeled bottle, placed in a convenient place in his laboratory, is a constant reminder.

A dental museum, in which are mounted specimens of normal and abnormal tooth forms, is valuable as a teaching aid in proportion to the number and variety of the specimens contained therein and the frequency with which they are used. The students should be stimulated to deposit especially perfect or anomalous specimens in this museum, the name of the donor being displayed, which will act as an incentive to their accumulation.

The technic work in instrument making is, in the opinion of the writer, extremely important. The student should be given as much work in the manipulation of steel as time will permit. The accompanying illustration (Fig 228) of excavator blanks is intended as an aid in ordering blanks of the proper size. The set of nine blanks (Clev-Dent.) will make the entire set of Black's cutting instruments, as follows, *viz:*

Blank No. 1.—Nos. 5, 6, 11, 12, 17, 18, 23, 24, 29, 30, 35, 36, 41, 42, 47, 48, 87, 88.

Blank No. 2.—Nos. 2, 3, 4, 8, 9, 10, 16, 22, 27, 28, 33, 34, 40, 46, 83, 86.

Blank No. 3.—Nos. 1, 7, 25, 26, 31, 32, 82, 85, 91, 94.

Blank No. 4.—Nos. 81, 84.

Blank No. 5.—Large chisels and specials.

Blank No. 6.—Nos. 15, 21, 53, 54, 59, 60, 65, 66, 71, 72, 95, 96, 98, 100, 102.

Blank No. 7.—Nos, 13, 14, 19, 20, 37, 38, 39, 43, 44, 45, 51, 52, 57, 58, 63, 64, 69, 70, 77, 78, 79, 80, 97, 99, 101.

Blank No. 8.—Nos. 49, 50, 55, 56, 61, 62, 67, 68, 73, 74, 75, 76.

Blank No. 9.—Nos. 89, 90, 92, 93.

The technic exercises in cavity preparation and filling may be performed on natural teeth or on some of the numerous

FIG. 229.—The Typodont. No. 1.

technic forms, in the judgment of the teacher. If a sufficient number of extracted teeth suitable for the purpose are available there is a great advantage in their use, as the student is thus early familiarized with the cutting consistence of natural tooth structure, is taught where to place his cavity walls in their relation to the pulp, and is enabled to perform proper

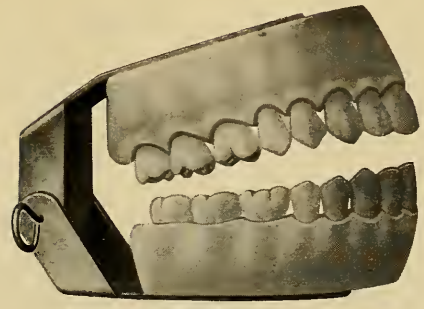


FIG. 230.—The typodont. No. 2.

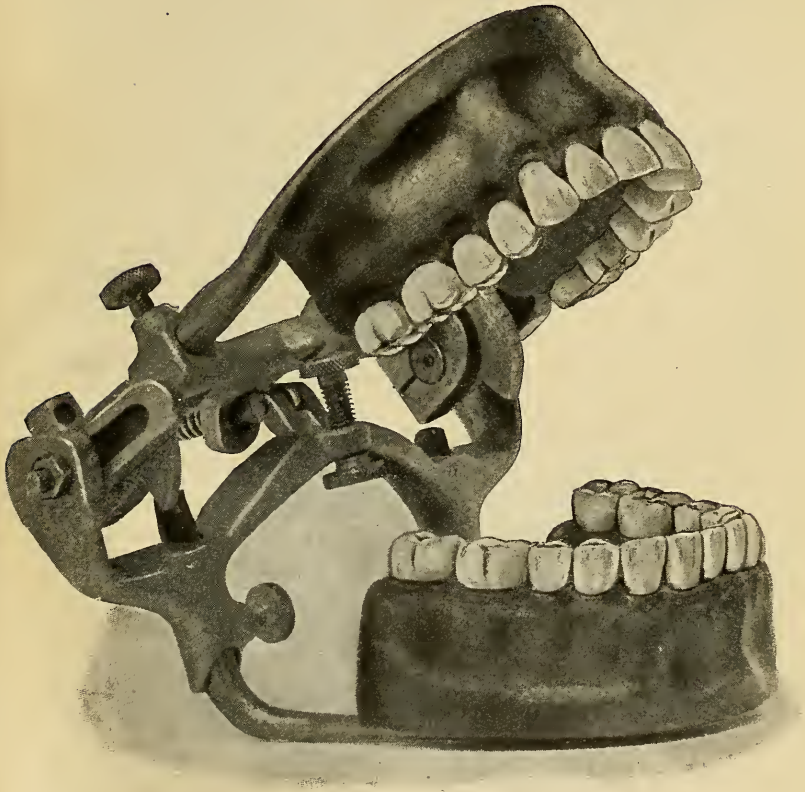


FIG. 231.—The odontotype. Nos. 1 and 2.

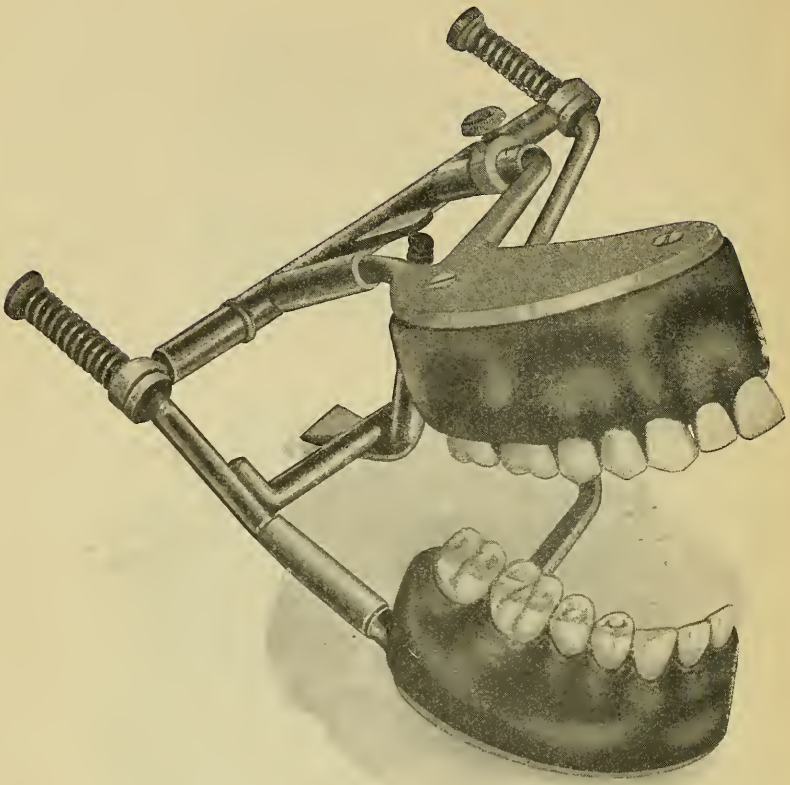


FIG. 232.—The odontotype. Nos. 6 and 7.

FIG. 233.—The Wright Dental Manikin. Designed by Dr. Edwin P. Wright. A metallic head with soft rubber (removable) lips and cheeks.

enamel bevels. The principal disadvantage of the technic blocks is that they do not allow a proper comprehension on the part of the beginner of these important points.

Of the technic forms available, the Typodont, Lee S. Smith & Co. (Figs. 229 and 230), and the Wenker Odontotypes (Figs. 231 and 232), are the best. In making a selection from these, it should be borne in mind that the student should comprehend the necessity of proper *contact* and *occlusion* in the building of fillings and of *separation* to accomplish the former. None of these forms adequately provide for the application of all of the principles mentioned, but the Wenker

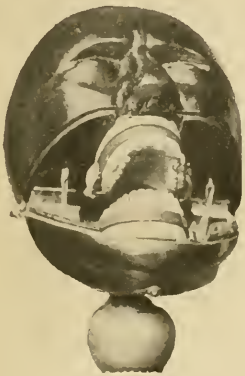


FIG. 234.

FIG. 235.

FIG. 234.—Wright manikin. Rubber face piece removed. Removable vulcanite teeth. The entire jaws are also removable. The head rests in a ball and socket joint and may be fixed in any position.

FIG. 235.—Wright manikin. The appliance rests on a telescoping iron stand which is attached to the floor. The manikin is useful for teaching operative technics.

forms with ivory teeth and soft rubber base to allow for separation are the most valuable ones yet devised.

At the New York College of Dentistry there is in use an aluminum manikin, which may be fastened to the head-rest of the chair or to the laboratory work-bench. It is an improvement on the Wright manikin, (illustrated in Figs. 233, 234 and 235) for teaching operative technics.

At the end of the course the technic work should be assembled in as attractive a manner as possible, arranging the pieces in chronological order. The work should be returned to the students at the completion of their course, as it will be found that they will take a great deal more interest in finishing and assembling, if they know that they will receive it again.

Every teacher desires to put his own individuality into the teaching of his course, and without that any course is a failure; but it is believed that the suggestions here given will be helpful in formulating and systematizing an outline for the year's work.

TECHNIC COURSE SUGGESTED BY THE AUTHOR

The following table is an outline of the technical exercises described in the previous chapters. It offers to the teacher a wide scope in the matter of selection. The exercises marked with an asterisk are the ones which the author recommends.

DENTAL ANATOMY

A. **Drawings.**

*1. Outline drawing, three diameters, of the labial surface of the crown and root of the right upper central incisor.

*2. Outline drawing, three diameters, mesial or distal surface of the crown and root of the upper central incisor.

*3. Shaded drawing, three diameters, labial surface of the upper central incisor.

*4. Outline drawing, three diameters, labial surface of the crown and root of the right upper cuspid.

*5. Shaded drawing, three diameters, of the labial surface of the same tooth.

*6. Outline drawing, three diameters, of the buccal surface of the crown and root of the right upper first bicuspid.

*7. Outline drawing, three diameters, of the mesial or distal surface, crown and roots of the same tooth.

*8. Shaded drawing, three diameters, buccal surface of the crown and root of the upper second bicuspid.

*9. Outline drawing, three diameters, of the mesial or distal surface of the lower first bicuspid.

*10. Shaded drawings, three diameters, of the occlusal surfaces of the upper first and lower second bicuspids.

*11. Outline drawing, not to measurement, of the buccal surfaces, of the upper and lower bicuspids, showing the most frequent location of the points of the cusps.

*12. Outline drawing, three diameters, of the buccal aspect of the crown and roots of the right upper first molar.

*13. Shaded drawings, three diameters, of the occlusal surfaces of the right upper first, second and third molars.

*14. Outline drawing, not to scale, showing the molar triangles.

*15. Outline drawings, not to scale, of three cubical figures, indicating the location of the surfaces, margins and angles of the lower molars.

*16. Shaded drawings, three diameters, of the buccal surfaces of the crown and roots of the left lower first and second molars.

*17. Shaded drawing, three diameters, of the mesial surface of the crown and roots of the lower first molar.

*18. Shaded drawing, three diameters, of the occlusal surface of the left lower first molar.

*19. Shaded drawing, three diameters, of the occlusal surface of the right lower second molar.

*20. Outline drawing, not to scale, showing the teeth in occlusion.

*21. Outline drawing, not to scale, showing the labio-lingual inclination of the upper and lower central incisors.

*22. Outline drawing, showing the mesial inclination of the same teeth.

*23. Outline drawing, showing the bucco-lingual inclination, of the upper and lower molars.

*24. Shaded drawing, showing the enamel, dentin, cementum and pulp of the upper central incisor.

B. **Carvings.**

1. **Carving Teeth in Plaster.**—Carve to Black's measurements, five diameters, the upper central and lateral incisors, the upper cuspid, upper first bicuspid and upper first molar. Preliminary cavity preparation work is done on these later.

2. **Carving Teeth in Soap.**—Carve all the teeth, upper and lower of one side, to exact measurement.

*3. **Carving Teeth in French Chalk.**—Carve to scale the upper and lower central and lateral incisors, the upper and lower cuspids, the upper first and lower first and second bicuspids, the upper first and lower first and second molars.

4. **Carving Teeth in Ivory.**—Carve to exact measurement the upper central and lower lateral incisors, upper and lower cuspids, upper first bicuspid, lower first and second bicuspids, upper and lower first molar, of one side.

*C. **Sawing and Filing Sections.**—Make one longitudinal and three transverse sections of the upper and lower teeth, right or left side.

D. **Making Prints.**—Make prints in ink of the sections cut.

OPERATIVE TECHNICS

A. **Instrument Making.**

*1. Make from piano wire six smooth broaches.

*2. Make from the same material six hooked extractors.

*3. Perform the exercises on pages 42, 43 and 44 illustrating Annealing, Hardening and Tempering.

*4. Make from steel blanks six excavators or chisels.

*5. Make from annealed brass wire, 13-gauge, the blade and shank of all the excavators and chisels in the college list.

B. **Cavity Preparation.**

*1. **Drawings.**—Outline drawings of the outline form of typical cavities in the occlusal surfaces of upper bicuspids, lower bicuspids, upper molars, lower molars, and the proximal surfaces of the anterior teeth.

*2. **Preparing Mortise Forms.**—Carve to form six cubes of plaster of Paris, 2 inches square, and on these prepare:

(a) The simple mortise form, one surface.

(b) The simple mortise form, two surfaces.

(c) The simple dovetail mortise form, one surface.

(d) The simple dovetail mortise form, two surfaces.

(e) The compound mortise form (step form).

(f) The compound dovetail mortise form.

Study the names of the cavity walls and line and point angles in these imaginary cavities.

(g) Deepen the convenience angles and bevel the margins.

*3. **Preparing Cavities in the Bone Handle.**—Prepare six cavities in the bone handle, to be later filled with non-cohesive tin.

4. **Preparing Cavities on Enlarged Plaster Teeth.**—Prepare six cavities on the enlarged plaster teeth, carved in the Dental Anatomy Technic Course.

5. **Preparing Cavities in Ivory Teeth.**—Prepare six cavities in the ivory teeth carved in the same course. See page 31.

6. **Preparing Cavities in Extracted Teeth.**—Prepare six cavities in extracted teeth. In case sufficient work in sawing and filing sections has not been done to impress upon the student's mind the relative thickness of enamel and dentin and the relation of the pulp chamber to the tooth surface,

the work in cavity preparation on extracted teeth may be preceded by exercises in splitting natural teeth and a study of these points.

*7. **Preparing Cavities on the Technic Form.**—Prepare on the Odontotype or the Typodont cavities illustrating all the various classes, to be filled later, some with amalgam, others with gold.

C. **Pulp Treatments.**

*1. Mount in plaster of Paris an upper central incisor, a cuspid, an upper first bicuspid (two roots), an upper second bicuspid (one root), an upper and a lower molar.

*2. Establish the outline form, remove the decay and make the cavities slightly retentive.

*3. Perform the operations of pulp capping, pressure anesthesia and devitalization on these teeth.

*4. Open the pulp chambers and canals and seal in treatments of various kinds, practising the two methods of wrapping broaches.

*5. Dry and fill the canals.

*6. Complete the cavity preparation, and place cement intermediates, building some to step form.

D. **Filling.**

*1. Fill three of the above cavities in the treated teeth with base plate gutta percha and three with cement.

*2. Perform the experiment described on page 131 in mixing and staining cement.

*3. Make from tin foil, specimens of the roll, rope, ribbon, cylinder and mat.

*4. Fill the cavities in the bone handle with tin foil.

5. Fill the cavities prepared in the ivory teeth.

6. Fill the cavities prepared in the extracted teeth.

*7. Fill the cavities prepared on the technic form with amalgam and gold.

INDEX

D

E

T

V